ENGINEERING

An Illustrated Weekly Journal

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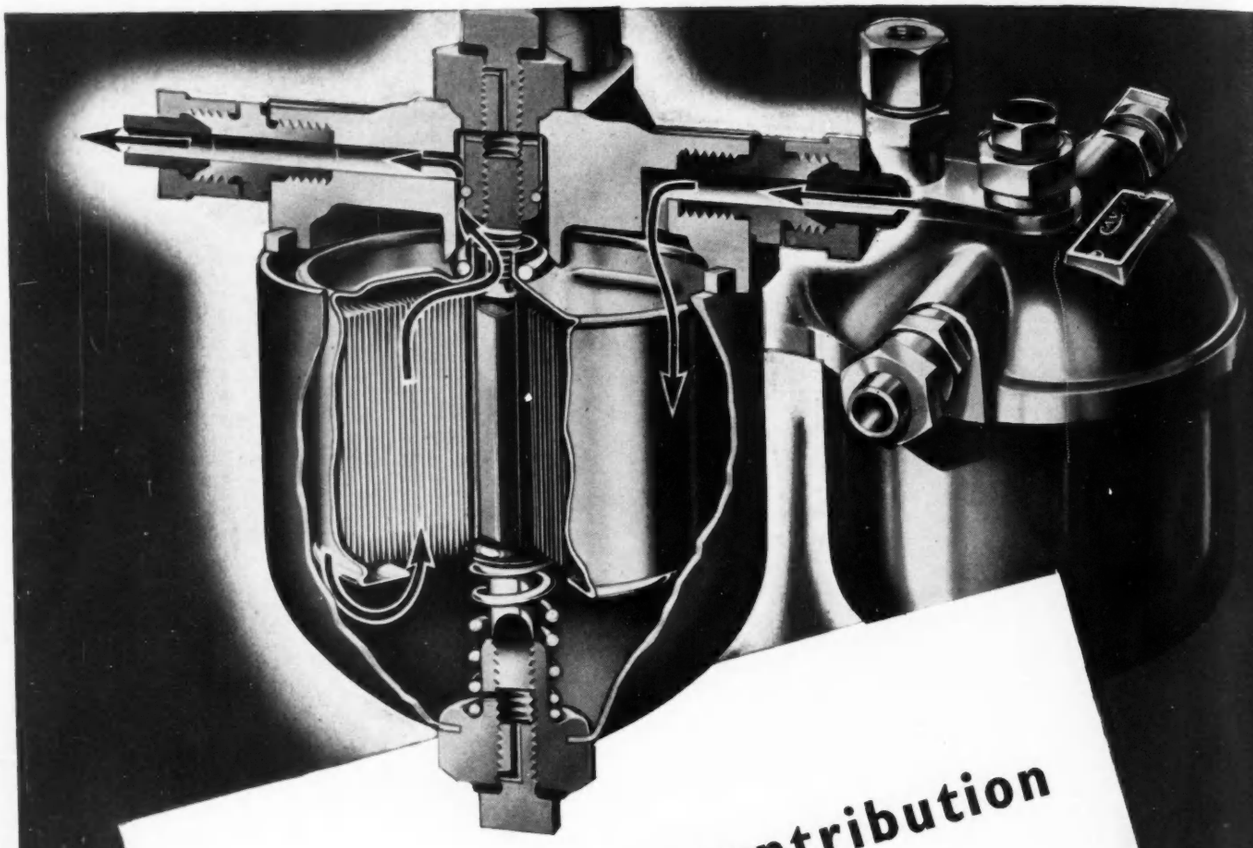
FORGING



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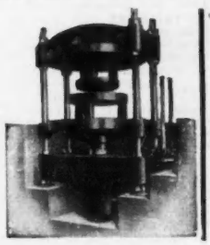

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- Close regulation within ± ½ p.s.i. at low reduced pressures.
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CLASSIFIED ADVERTISEMENTS SECTION.

For all advertisements classified under the headings of Tenders, Appointments Open, Situations Wanted, Patent Agents, Partnerships, Wanted, &c., Auction Sales, Publications For Sale, Miscellaneous and Public Notices, &c., the charge will be 12s. for the first four lines or under and 3s. per line up to one inch. When an advertisement measures an inch or more, the charge will be at the rate of 36s. per inch. 5% allowed on 6, 10% on 13, 15% on 26 and 20% on 52 Weekly insertions. If use is made of a box number the extra charge is 2s. per insertion with the exception of advertisements appearing under Situations Wanted. Prospectuses and Notices of Company Meetings £25 per column. Copy instructions must be in our hands first post Monday for the following Friday's issue. Address to the Manager, ENGINEERING LTD., 35 and 36, Bedford St., Strand, W.C.2 Inclusion of advertisements must be dependent on space being available.

EDUCATIONAL.

FREE. Brochure giving details of courses in Mechanical and Production Engineering, Draughtsmanship, etc., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other Professional examinations. H.M.I. INSTITUTES, DEPT. EG. 30, LONDON, W.4. (ASSOCIATED WITH H.M.V.) G 619

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COURSES.

COUNTY BOROUGH OF BOURNEMOUTH.

BOURNEMOUTH MUNICIPAL COLLEGE OF TECHNOLOGY AND COMMERCE.

Principal: M. L. YATES, M.A. (Com), M.Sc.Tech., Ph.D., M.I.Mech.E.

Full-time and part-time courses are provided in preparation for the following :—

B.SC. GENERAL (Chemistry, Physics, Biology, Mathematics).

B.SC. ENGINEERING (Electrical, Mechanical).

B.SC. ECONOMICS.

University of London External Degrees.

ACCOUNTANCY.

Provision is made for students' social and athletic interests.

Applications for admission should be addressed to the PRINCIPAL, from whom any further particulars required may be obtained. Telephone: Bournemouth 1520-1. M 150

TENDERS.

MANCHESTER REGIONAL HOSPITAL BOARD.

NOTICE TO ALL BUILDING AND ENGINEERING CONTRACTORS.

The Manchester Regional Hospital Board propose to maintain an

APPROVED LIST OF CONTRACTORS for the execution of works of new building construction, adaptations of existing buildings and engineering works, and, unless in any particular case and for particular reasons the Board shall direct otherwise, tenders for the carrying out of such works at any of the hospitals and clinics administered by the Board will only be invited from firms or persons whose names are included in the Approved List. The Board's area covers parts of four counties—Lancashire, Derbyshire, Cheshire and Westmorland. Contractors who wish to be considered for inclusion in the List should apply to the SECRETARY OF THE BOARD, CHEETWOOD ROAD, MANCHESTER, 8, not later than 14th July, 1956, for form of application and further details. M 165

THE HIGH COMMISSIONER FOR INDIA invites **TENDERS** for the supply of:—

	Quantity. Nos.
MAIN BAR FRAME SLABS ...	L.H.221 R.H.221

Forms of tender may be obtained from the DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, on or after 22nd June, 1956, at a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to " High Commissioner for India." Tenders are to be delivered by 2 p.m. on Friday, 3rd August, 1956.

Please quote reference No. 98/56/RLY. M 132

MANCHESTER COLLEGE OF TECHNOLOGY.

RENEWAL OF EXISTING VENTILATING PLANT.

Applications are invited from Ventilating Engineers as soon as possible for the

RENEWAL OF THE EXISTING VENTILATING PLANT at the College comprising fans, filters, heater batteries, etc. All applications will be considered and firms invited to submit a **SCHEME AND TENDER** on the basis of a prepared General Specification.—Apply to THE BURSAR, COLLEGE OF TECHNOLOGY, SACKVILLE STREET, MANCHESTER, 1. M 128

THE HIGH COMMISSIONER FOR INDIA invites **TENDERS** for the supply of:—

	Quantity. Lbs.
BARE COPPER WIRE 42 S.W.G. SOFT ANNEALED ON SPOOLS	21,800

Forms of tender may be obtained from the DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDING, BROMYARD AVENUE, ACTON, LONDON, W.3, on or after 22nd June, 1956, at a fee of 10s., which is not returnable. If payment is made by cheque, it should please be made payable to " High Commissioner for India." Tenders are to be delivered by 2 p.m. on Friday, 27th July, 1956.

Please quote reference No. 75/56/RLY. M 111

THE DIRECTOR GENERAL, INDIA STORE DEPARTMENT, GOVERNMENT BUILDINGS, BROMYARD AVENUE, ACTON, LONDON, W.3, invites

TENDERS for the supply of:—

RECUPERATOR EQUIPMENT FOR CUPOLA FURNACE.

Forms of tender, which are returnable by 3rd August, 1956, may be purchased at the above address at a cost of 10 shillings.

In your application for tender please quote reference No. 1558/56/SMM/CIV.2. M 148

THE MARITIME SERVICES BOARD OF NEW SOUTH WALES.
CONTRACT NO. 56/4.

EXTENSION OF CLOSING DATE.

TENDERS will now be received until 31st August, 1956, for the supply, manufacture, testing, delivery and maintenance of one 16-in. Cutter Suction Dredge (non-propelled):

(*a*) delivered completely assembled, or
(*b*) delivered in prefabricated parts for assembly by the Board,

with complete equipment including two 16-in. pumps in series, separately driven by diesel engines of at least 500 b.h.p., and suitable for dredging from a depth of 42 ft. whilst delivering through floating and shore pipe line not less than 5800 ft. long. Main and auxiliary diesel driven alternator sets are also required.

Specifications may be obtained on application from the Agent General for New South Wales, 56/57, Strand, London, W.C.2.

Tenders in sealed envelopes, endorsed " Tender for 16 in. Cutter Suction Dredge, Contract 56/4 " must be delivered to the HEAD OFFICE OF THE MARITIME SERVICES BOARD, CIRCULAR QUAY WEST, SYDNEY, NEW SOUTH WALES, not later than 2 p.m. on Friday, 31st August, 1956. M 184

PUBLIC APPOINTMENTS.

DERBYSHIRE EDUCATION COMMITTEE.

CHESTERFIELD COLLEGE OF TECHNOLOGY.
Principal: E. CARDWELL, M.Sc. (Lond.), Wh.Ex., M.I.Mech.E.

Applications are invited for the following full-time posts with effect from the 1st September, 1956, or as soon thereafter as possible:—

ASSISTANTS, GRADE B, in the DEPARTMENT OF MECHANICAL AND CIVIL ENGINEERING—

1. To teach Mechanical Engineering subjects to Higher National Certificate level. Ability to teach Mathematics to A.1 standard an advantage.
2. To teach National Certificate subjects in Mechanical and Production Engineering together with Workshop Technology and Practice to final City and Guilds standard in Machine Shop Engineering.

SENIOR LECTURER in the DEPARTMENT OF ELECTRICAL ENGINEERING AND MATHEMATICS.

Candidates should possess an Honours Degree of a British University and have had experience in the teaching of Mathematics. The person appointed will be required to teach Pure and Applied Mathematics to B.Sc. (Eng.) standard and will be responsible for the organisation of the teaching of Mathematics throughout the College.

Salary will be in accordance with the Burnham Technical Report including additions for Graduates and allowances for teaching and approved industrial experience where appropriate. Further particulars and forms of application from the undersigned (stamped addressed foolscap envelope required), to whom applications should be returned by 3rd July, 1956.

S. A. BROADWELL,
REGISTRAR.

COLLEGE OF TECHNOLOGY,
INFIRMARY ROAD,
CHESTERFIELD. M 61

BLACKPOOL EDUCATION AUTHORITY.

TECHNICAL COLLEGE AND SCHOOL OF ART.

Required

ASSISTANT, GRADE "A" TO TEACH ENGINEERING SUBJECTS.

Forms of Application and further particulars from the CHIEF EDUCATION OFFICER, 3, CAUNCE STREET, BLACKPOOL, should be returned as soon as possible.

E. C. LEE,
Town Clerk. M 208

UNIVERSITY COLLEGE OF SWANSEA.

Applications are invited for EITHER an

ASSISTANT LECTURESHIP OR **A LECTURESHIP IN ELECTRICAL ENGINEERING.** It is desirable but NOT essential that candidates' interest be in one of the fields: transistor circuitry; control systems, which can be large power speed control apparatus; or aerials.

Salaries:

Assistant Lectureship, not less than £550 per annum.

Lectureship, £650 by £50 to £1350 per annum.

Commencing salary in each case will be at a point on the appropriate scale according to age, qualifications and experience. Membership of the F.S.S.U. and children's allowance scheme.

Further particulars may be obtained from THE REGISTRAR, UNIVERSITY COLLEGE, SINGLETON PARK, SWANSEA, to whom applications (six copies) must be sent by JULY 16, 1956. L 979

STATE ELECTRICITY COMMISSION OF VICTORIA.

SENIOR POWER STATION STAFF.

The State Electricity Commission of Victoria seeks applications from engineers with the requisite qualifications and experience for appointment to its **SENIOR POWER STATION STAFF** in positions and at salaries commensurate with their qualifications and experience.

The salaries of Power Station Superintendents range from £A2166 (minor stations) to £A2566 (major stations) and Assistant Power Station Superintendents from £A1784 to £A2316 respectively. These salaries include the current cost of living adjustment of £A466 per annum and are the maxima for these positions.

The Commission is constituted as a semi-government authority by Act of Parliament and is one of the largest electricity supply authorities in the Commonwealth of Australia and is the largest producer of fuel with brown coal and briquette enterprises in the Latrobe Valley. It has a capital investment of approximately £200 million, with an annual revenue of £A29 million.

The major steam stations are situated in the Latrobe Valley approximately 90 miles east of Melbourne and in the Melbourne Metropolitan area. The minor steam stations are situated in the provincial cities of Ballarat, Geelong and Mildura. The rapid expansion of the Commission's system involves the construction of additional steam power stations of up to 500 MW capacity in the Latrobe Valley, burning brown coal.

Applicants should have the ability to deal with the day-to-day technical and administrative problems of a power station with its associated technical staff and labour forces and have had extensive experience in power station operation and maintenance. They should hold appropriate technical qualifications, but a University Degree or Higher National Certificate in Mechanical or Electrical Engineering, or membership of a recognised Engineering Institute is preferred.

A married appointee if allotted to the Latrobe Valley could be housed immediately; and in provincial cities, within a reasonable time of taking up duty. No assistance can be given in the matter of housing in Melbourne. The Commission will pay reasonable living expenses of married appointees and their families for a period of six months unless a house is obtained earlier.

Married appointees will be reimbursed at the expiration of six months' satisfactory service an amount of up to £A100 upon production of necessary receipts, in respect of removal of household furniture and effects.

Appointees and their families can be transported to Australia under the Commonwealth Government's Migration Scheme, details of which are available from officials at Australia House, The Strand, London.

Further information may be obtained on application to the Staff Superintendent at the address mentioned below.

Arrangements will be made for representatives of the Commission to interview selected applicants in England.

Applications, giving full details of qualifications experience and war service (if any), stating date of birth and accompanied by copies of testimonials, should be submitted not later than 21st July, 1956, to the Secretary:

STATE ELECTRICITY COMMISSION OF VICTORIA,
22-32 WILLIAM STREET, MELBOURNE, C.I.
VICTORIA, AUSTRALIA. L 998

NEWCASTLE REGIONAL HOSPITAL BOARD.

APPOINTMENT OF DEPUTY REGIONAL ENGINEER.

Applications are invited for the appointment of **DEPUTY REGIONAL ENGINEER** to the Board.

Candidates must be Corporate Members of the Institution of Civil Engineers, Mechanical Engineers, or Electrical Engineers and must have had wide experience in engineering design and operation in all types of hospitals.

The person appointed will be required to deputise for the Regional Engineer over the whole engineering field and to supervise the design of engineering projects and the preparation of technical reports.

The appointment is superannuable and is terminable by three months' notice on either side. Salary: £1195 by £40 (4) by £30 (1) to £1425. The terms and conditions of the appointment are as laid down by the Whitley Council.

Applications, stating full details of age, qualifications, present and past appointments, etc., together with the names and addresses of three referees (two technical) should be forwarded to the SECRETARY OF THE BOARD, WALKER GATE HOSPITAL, BENFIELD ROAD, NEWCASTLE-UPON-TYNE, 6, not later than 14th July, 1956. M 171

GOVERNMENT OF BRITISH GUIANA.

INSPECTOR OF LABOUR (FACTORIES) required to inspect factories, advise on legislation relating to working and safety conditions and train local officers. Experience as factory inspector essential with *either* degree or professional equivalent in mechanical or electrical engineering, or sound engineering experience including knowledge of steam boilers and pressure vessels. Three-year contract. Salary scale £950 to £1200 with lump sum gratuity (point of entry according to experience). Free passages. Generous leave, low Income Tax. Further particulars and application forms from DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, GREAT SMITH STREET, LONDON, S.W.1, quoting BCD. 132/30/01. Closing date for receipt of initial enquiries 12 July, 1956. M 4

ADMIRALTY require

PRODUCTION ENGINEERS (UNESTABLISHED) in various places in U.K. Various duties in production of mechanical, electrical and electronic equipment for H.M. Ships and include design for production, advice on production methods and preparation of estimates. Must have recognised apprenticeship or equivalent training, and possess a University Degree, A.M.I.Mech.E., A.M.I.E.E. or exempting qualifications. Age not less than 25. Salary scale £741 to £1160. Starting salary from £741 at age 25 up to £1018 according to age.—Forms, quoting C67/6A, from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1. G 668

AIR MINISTRY Works Designs Branch requires (A) in LONDON.

(1) DESIGNER/DRAUGHTSMEN (Order No. 1005) for bulk petroleum storage and pumping installations experienced in one or more of the following:—

(*a*) Storage tank layout and design, (*b*) pump house and plant layout, (*c*) development of pipe line schemes, (*d*) hydraulic calculations. Technical training to O.N.C. standard required. Salaries up to £761 p.a.

(2) STRUCTURAL ENGINEERING DESIGNER/DRAUGHTSMEN (Order No. 1001) for reinforced concrete or structural steel work with sound technical training and several years varied experience in design/detailing of:—

(*a*) Reinforced concrete construction for all types of buildings, or (*b*) steel framed sheds, warehouses and similar buildings, and

CIVIL ENGINEERING DESIGNER/DRAUGHTSMEN (Order No. 1002) experienced in one or more of the following branches of engineering:—

(*a*) Earthworks and Stormwater Drainage, (*b*) Foul Drainage and small disposal works, (*c*) Water Pumping Treatment and Distribution. Salaries up to £898 p.a.

(B) IN LONDON AND PROVINCES (with liability for overseas service)

ELECTRICAL ENGINEERING DRAUGHTSMEN (Order No. 1004) experience in preparation of schemes for illumination and electrical equipment of buildings or in electrical distribution H.V. and M.V. Technical training to O.N.C. standard or equivalent an advantage. Salaries up to £898 p.a. Starting pay dependent upon age, quals. and experience. Paid overtime. Long term possibilities with pensionable and promotion prospects. Four weeks' leave a year. Normally natural born British subjects. Write, stating age, quals., employment details incl. type of work done to any Employment Exchange quoting Borough and relevant Order No. G 657

UNIVERSITY OF LONDON.

The Senate invite applications for the **READERSHIP IN ELECTRICAL ENGINEERING** tenable at the Imperial College of Science and Technology (salary, £1300-£1550-£1800 a year). Applications (10 copies) must be received not later than 6th July, 1956, by the ACADEMIC REGISTRAR, UNIVERSITY OF LONDON, SENATE HOUSE, W.C.1, from whom further particulars may be obtained. M 120

THE UNIVERSITY OF MANCHESTER.

Applications are invited for the post of **LECTURER IN ENGINEERING (MECHANICAL).** Preference will be given to candidates with a major interest in heat transfer. A knowledge of some aspect of Nuclear Engineering would be an advantage. University regulations permit teaching staff to read for the degrees of M.Sc. and Ph.D. Applications will also be considered from engineers who would be interested in a temporary appointment of two or more years. Salary scale: £650 to £1350 per annum. Membership of F.S.S.U. and Children's Allowance Scheme. Initial salary according to qualifications and experience. Applications should be sent not later than July 9th, 1956, to the REGISTRAR, THE UNIVERSITY, MANCHESTER 13, from whom further particulars and forms of application may be obtained. Applications by airmail (no forms) will be considered from overseas candidates. M 118

METALLURGIST—Wanted for South African Steelworks. Assistant Works Metallurgist with knowledge chemical analysis, steelmaking, manufacture and heat treatment alloy and tool steels. Salary, £900 per annum and upwards according to experience. Good prospects. Fare paid to South Africa including family. Graduate preferred.—Apply in writing to LONDON REPRESENTATIVE, UNION STEEL CORPORATION (OF SOUTH AFRICA), LTD., 723, THE ADELPHI, LONDON, W.C.2, giving full details of experience and qualifications. M 116

SENIOR DESIGN ENGINEERS (ELECTRICAL)

Vacancies exist with the INDUSTRIAL GROUP OF THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY at its HEADQUARTERS AT RISLEY, WARRINGTON, LANCS., for (*a*) **SENIOR DESIGN ENGINEERS** and (*b*) **DESIGN ENGINEERS.**

DUTIES:—

(*a*) **SENIOR DESIGN ENGINEER** (Ref. No. 1466).
Responsible to the Assistant Chief Engineer for the organisation and control of a number of sections engaged upon the design and specification of electrical equipment for large factories, including H.T. & L.T. switchgear and substations, installations and distribution systems.

(*b*) **DESIGN ENGINEER** (Ref. No. 1467).
Responsible to a Senior Design Engineer for a section of the work described above.

QUALIFICATIONS AND EXPERIENCE:
Applicants for both posts should have served a recognised electrical apprenticeship and be Corporate Members of the Institution of Electrical Engineers, or hold equivalent qualifications, and have had appropriate experience. It is essential that candidates as Senior Design Engineers should have had extensive experience of all types of electrical installations and wiring systems and be accustomed to controlling technical staff.

SALARY:
(*a*) **SENIOR DESIGN ENGINEER,** £1581, rising by annual increments of approximately £45 to £1776 per annum.
(*b*) **DESIGN ENGINEERS,** £1199, rising by annual increments of approximately £40 to £1504 per annum.

A contributory pension scheme is in operation.

Authority houses for renting may be available in due course or, alternatively, substantial assistance may be given towards legal expenses incurred by married officers wishing to purchase their own houses.

Suitably qualified persons are invited to send a post-card for application form, quoting the appropriate reference number, to the RECRUITMENT OFFICER, UNITED KINGDOM ATOMIC ENERGY AUTHORITY (I.G. HQ.), RISLEY, WARRINGTON, LANCS.

Closing Date—6th July, 1956. M 112

THE WEST OF SCOTLAND AGRICULTURAL COLLEGE.

Applications are invited for **TWO POSTS OF JUNIOR ASSISTANT LECTURER IN AGRICULTURAL ENGINEERING AND SURVEYING** from candidates with a suitable degree or equivalent qualification and some knowledge of farm implements and machinery. For one of the posts a qualification in electrical engineering is required.

Salary scale (inclusive) Grade IVb (Intermediate) £509 rising to £721 with promotion to a higher scale after a probationary period.

Conditions of appointment and application forms may be obtained from the SECRETARY, 6, BLYTHSWOOD SQUARE, GLASGOW, C.2, with whom applications should be lodged not later than 10th July, 1956. M 161

LOUGHBOROUGH COLLEGE OF TECHNOLOGY.

Principal: H. L. HASLEGRAVE, Wh.Sc., M.A. (Cantab.), Ph.D. (London), M.Sc. (Eng.), M.I.Mech.E., M.I.E.E., M.I.Prod.E.

Applications are invited for the post of **SENIOR LECTURER IN THE DEPARTMENT OF AERONAUTICAL ENGINEERING.** The successful applicant will be required to teach Aerodynamics up to final Diploma and Degree standard. Applicants should hold a good honours degree or equivalent qualification, have had practical experience in industry, be cognisant of the latest developments in the theory of aerodynamics, and be able to develop wind tunnel and laboratory techniques.

The salary will be in accordance with the Scale for Senior Lecturers (Burnham Technical Report, 1954), namely, £1065 by £25 to £1215.

Further particulars and application forms may be obtained from the Registrar, to whom completed forms should be returned as soon as possible. M 151

SUDAN GOVERNMENT.

The Ministry of Irrigation and Hydro-Electric Power has a vacancy for a **CHIEF MECHANICAL ENGINEER.** The applicant must be a fully qualified engineer (A.M.I.Mech. or equivalent) not less than 40 years old and with a wide experience in the maintenance and operation of large pumps and modern earth-moving machinery.

Appointment will be on Short Term Contract (with or without bonus) for a period of up to five years terminable at any time by 3 months' notice on either side. Salary is £E.2250 p.a. (fixed rate) for Contract with bonus, and £E.2400 p.a. for Contract without bonus. On satisfactory completion of the contractual period, a bonus of one month's salary is payable for each year of service up to a maximum of six months' salary if he serves on Contract with bonus. A Cost-of-Living Allowance which is reviewed quarterly is payable, and also an Outfit Allowance of £E.50.

Further information and application form can be obtained from the SUDAN DIPLOMATIC MISSION IN LONDON, SUDAN HOUSE, CLEVELAND ROW, ST. JAMES, LONDON, S.W.1.—Applications should be received by June 28th, 1956. Please quote name and address, "CHIEF MECHANICAL ENGINEER 4/1305," IN BLOCK LETTERS. M 137

HERTFORDSHIRE COUNTY COUNCIL.

HATFIELD TECHNICAL COLLEGE, ROE GREEN, HATFIELD, HERTS.

Principal: Dr. W. A. J. CHAPMAN, M.Sc. (Eng.).

SENIOR LABORATORY TECHNICIAN required in the Department of Mechanical and Production Engineering. General workshop experience necessary as well as knowledge of the maintenance and manufacture of instruments and laboratory equipment. Duties to commence as early as possible. Salary Scale: £560 to £670 per annum, starting point according to qualifications and experience. Applications to the REGISTRAR. M145

GOVERNMENT OF QATAR—PERSIAN GULF.

STATE ENGINEER'S OFFICE.

Applications are invited for the following posts under the direction of the State Engineer, Government of Qatar, Doha:—

DESIGN ENGINEER:
Applicants for the post of Design Engineer should be qualified Civil Engineers (Associate Members of the Institution of Civil Engineers or other internationally recognised body) having particular experience of the layout and design of roads (bitumen macadam and reinforced concrete) and reinforced concrete structure together with a sound working knowledge of the design of water supply, Sewerage and sewage disposal schemes. Applicants should be rapid and competent draughtsmen.

The successful applicant will assist in the design of many of the Civil Engineering works associated with a rapidly expanding town.

ASSISTANT ARCHITECT:
Applicants for the post of Assistant Architect should be qualified Architects (Associates of Royal Institute of British Architects or other internationally recognised body) having good general experience of the design of private and public buildings. Applicants should be rapid and competent draughtsmen.

The successful applicant will assist the Government Architect in the design of the many architectural projects associated with a rapidly expanding town.

SALARY: For both above appointments will be according to Scale E2. Each starting at Rs. 1,775/= an Arabic month with annual increments of Rs.75/= a month up to Rs. 2,000/= and then by annual increments of Rs. 100/= per month to a maximum of Rs. 2,300/= per month. (Rs. 1,775/= an Arabic month is equivalent to £1,590/= Sterling a Gregorian year.)

GRATUITY: Payable on the basis of one month's pay for each completed year of service, on completion of contract only.

PROBATION: Probationary period of six months during which contract may be terminated at three months' notice by the Government, without stating its reason.

CONTRACT: A five-year contract subject to successful completion of the probationary period. The employee may terminate the contract at three months' notice only after completing one year's service.

ACCOMMODATION: Free furnished bachelor accommodation, fuel, light and water. Married accommodation will be provided in accordance with the rules but in no case before successful completion of probationary period.

LEAVE: Will be earned at the rate of 6 days for each completed month of duty.

FREE TRAVEL: On first journey to Qatar, leave not exceeding one return first class Air passage in each year and termination for applicant, wife and children up to 18 years of age.

GENERAL: The climate is hot for about five months of the year but this is offset by air-conditioning in staff houses and offices. Good climate for the rest of the year.

No income tax. Duty car allowance. Free medical and dental treatment.

Applications endorsed "Design Engineer" or "Assistant Architect," as the case may be, giving full personal particulars, including age, nationality, religion, education, marital status, qualifications, training, past experience and employment, names and addresses of three referees and latest photograph should be sent in duplicate to:

THE ADVISER TO THE GOVERNMENT OF QATAR,
P.O. BOX NO. 36,
DOHA, QATAR,
PERSIAN GULF.

A further copy with enclosures similarly endorsed should be sent to:

MESSRS. C. TENNANT, SONS & CO., LTD.,
4, COPTHALL AVENUE,
LONDON, E.C.2. M 153

TRACTION ENGINEER required by N.C.B.'s H.Q. Production Dept. for work involving a variety of interesting problems on both surface and underground throughout coalfields. The post is based on Stanhope Bretby, near Burton-on-Trent. Good technical qualifications and ability to carry out responsible work on design, development and testing of traction equipment required, with considerable experience with diesel and/or electric traction. Appointment (superannuable) within range £746 to £1310, according to qualifications and experience.

Write, with full particulars of age, education, qualifications and experience, to NATIONAL COAL BOARD, STAFF DEPT., HOBART HOUSE, LONDON, S.W.1, marking envelope SS/318, before 3rd July, 1956. M 155

THE ROYAL TECHNICAL COLLEGE, GLASGOW.
(In affiliation with the University of Glasgow.)

DEPARTMENT OF MECHANICAL, CIVIL AND CHEMICAL ENGINEERING.

SENIOR LECTURESHIP IN STRENGTH OF MATERIALS.

Applications are invited for a Senior Lectureship in Strength of Materials. Applicants should have a good Honours Degree and industrial or research experience. Teaching experience an advantage. Salary scale: £1400 by £50 to £1700, with F.S.S.U. and family allowances.

Further particulars and application forms can be obtained from the Secretary, THE ROYAL TECHNICAL COLLEGE, GLASGOW. M 126

MINISTRY OF SUPPLY
requires
ENGINEER OR CHEMIST at Harefield, Middlesex, to direct inspection of metallic materials used in guided weapons. Qualifications: Must have wide knowledge and experience of this type of work. Engineers need recognised engineering apprenticeship and A.M.I.Mech.E. or E.E. or exempting qualifications. Chemists, an Honours Degree in metallurgy or A.I.M., or equivalent. Salary within £711 (age 25)-£1120 p.a. Forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, S.W.1, quoting F.31/6A. M 168

SOIL MECHANICS ASSISTANTS.

Two vacancies exist in the Soil Mechanics Laboratory of British Railways, Western Region.

(1) **TECHNICAL ASSISTANT** to take charge of Soil Testing. Applicants should have had considerable experience and be able to supervise staff. Technical qualifications not essential.

(2) **TECHNICAL ASSISTANT** to carry out soil mechanics investigations. Experience in this work essential and degree or equivalent desirable.

The salaries of these posts commence at £770 p.a. and rise to £835 after four years.

Certain free and privilege travel facilities on British and Continental Rail systems exist.

Apply to CHIEF CIVIL ENGINEER, PADDINGTON STATION, LONDON, W.2. M 125

ROYAL TECHNICAL COLLEGE, SALFORD.

Acting Principal: J. F. YATES, B.Sc., M.Sc., M.I.E.E.

The Governors invite applications from people with a degree and/or professional equivalent for the posts shown below—

MECHANICAL ENGINEERING DEPARTMENT.

TWO LECTURERS. Applicants will be expected to teach Mechanical Engineering subjects up to Higher National Diploma level.

TWO ASSISTANT LECTURERS, GRADE B, to teach Mechanical Engineering subjects up to Higher National Certificate level.

Salaries in accordance with the Burnham Technical Report, viz.:

ASSISTANT LECTURER, GRADE B, £525-£820 (men); £475-£655, plus two-sevenths differential (women), plus graduate, training and approved industrial experience allowances.

LECTURER, £965-£1065 (men); £722-£852 plus two-sevenths differential (women).

These salaries are subject to revision under the new Burnham Scales which, it is hoped, will be published shortly.

For further particulars and forms of application please send a stamped addressed envelope to THE ACTING PRINCIPAL, ROYAL TECHNICAL COLLEGE, SALFORD, 5. Applications should be returned as soon as possible.

R. RIBBLESDALE THORNTON,
CLERK TO THE GOVERNORS. M 135

THE UNIVERSITY OF LIVERPOOL.

Applications are invited for the post of **LECTURER IN THE DEPARTMENT OF FLUID MECHANICS.** Applicants should have had training or experience in one of the following fields:—(*a*) Hydraulics; (*b*) Aerodynamics; or (*c*) Hydrodynamics. The initial salary will be within the range £650-£1350 per annum, according to qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than 23rd July, 1956, by the undersigned, from whom further particulars of the conditions of appointment may be obtained.

STANLEY DUMBELL,
REGISTRAR. M 108

THE UNIVERSITY OF LIVERPOOL.

Applications are invited for the post of **SENIOR LECTURER IN THE DEPARTMENT OF ELECTRONIC ENGINEERING,** at an initial salary within the range £1400-£1500 per annum, according to qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than 28th July, 1956, by the undersigned, from whom further particulars of the conditions of appointment may be obtained.

STANLEY DUMBELL,
REGISTRAR. M 109

CENTRAL ELECTRICITY AUTHORITY.
SOUTH EASTERN DIVISION.

ASSISTANT SHIFT CHARGE ENGINEER required at LITTLEBROOK POWER STATION. Applicants who should preferably be educated to H.N.C. standard must have had experience in the generation of modern high pressure turbine and boiler plant, E.H.T. switchgear and in the control of labour. P.F. experience an advantage. N.J.B. Conditions of Service, Class L, Grade 9, £1109 15s.-£1194 p.a. including London and shift allowances.—Applications giving qualifications, experience, positions held, etc., should be sent to the STATION SUPERINTENDENT, LITTLEBROOK POWER STATION, NR. DARTFORD, KENT, to arrive by 30th June. M 187

TRAINED INSTRUMENT MAKER required on 1st September, or as soon as possible afterwards at Cambridgeshire Technical College and School of Art for a full-time teaching appointment concerned primarily with day release courses for apprentices leading to City and Guilds of London Institute awards in Instrument Making. Higher National Certificate in Mechanical Engineering or its equivalent and wide experience of instrument making technique are desirable qualifications.

The salary scale will normally be that for Grade A Assistants (£450 by £18 to £725), but an exceptionally qualified applicant may be appointed to Grade B (£525 by £25 to £820). Additional allowances are payable for a degree and training. Starting salary depends on previous teaching and industrial experience and war service. Scales are now under review and likely to be increased in the near future.

Further particulars and forms of application from THE PRINCIPAL, CAMBRIDGESHIRE TECHNICAL COLLEGE AND SCHOOL OF ART, COLLIER ROAD, CAMBRIDGE. M 190

THE BRITISH SOCIETY FOR RESEARCH IN AGRICULTURAL ENGINEERING requires a **SCIENTIFIC OFFICER** to work on wheel research and testing of crop driers. 1st or 2nd class hons. degree in engineering or physics essential and interest in applied mechanics and thermodynamics desirable. Salary £539-£933, starting pay according to age and post-graduate experience. F.S.S.U.—Application forms from SECRETARY, N.I.A.E., WREST PARK, SILSOE, BEDS. M 202

Classified Advertisements continued on Page 4

AIR POLLUTION HANDBOOK

Edited by PAUL L. MAGILL, Senior Scientist
FRANCIS R. HOLDEN, Senior Chemist
CHARLES ACKLEY, Technical Report Editor
of the Stanford Research Institute

This highly authoritative book, written by a number of specialists offers much helpful theoretical, technical and practical information on the problems of air pollution, its causes, effects and control in a very convenient reference form.

The wide range of treatment includes such diverse topics as city planning and plant location in relation to air pollution control, the chemistry of contaminated atmospheres, kinds of pollutants harmful to animals, procedures for sampling contaminated atmospheres, experimental test methods and legal considerations.

All facts needed by all types of readers concerned with determining the value, extent and effect of air pollution in specific situations are very accurately compiled together with information on the effective measures needed for abating this problem.

672 pages approx. £4 14 0

COMPOSITION & PROPERTIES OF CONCRETE

GEORGE E. TROXELL, Professor of Civil Engineering
University of California
HARMER E. DAVIS, Professor of Civil Engineering
University of California

This book is split into two parts.

Part 1 is a descriptive treatment of the characteristics of cements, aggregates, admixtures and water used in concrete mixes—the proper proportioning of the materials (with examples), and the batching, mixing, placing and airing of concrete in order to produce a finished product of suitable and predictable quality and economy.

Part 2 consists of instructions for laboratory tests selected to illustrate the most important facts and principles connected with the use of cement, aggregate and concrete.

415 pages Approx. 64s. *To be published Oct.-Nov.*

McGRAW-HILL PUBLISHING CO LTD
McGraw-Hill House, London, E C 4

WOLVERHAMPTON AND STAFFORDSHIRE TECHNICAL COLLEGE.

Principal: C. L. OLD, B.Sc. (Eng.), M.Sc.Tech.

Applications invited for

GRADE B ASSISTANT to teach METAL WORKING PROCESSES AND PRACTICE in City and Guilds and National Certificate courses. Aptitude for machine tool demonstration. Industrial experience with possession of Full Technological Certificate in Machine Shop Engineering and/or H.N.C. required.

Salary in accordance with Burnham Technical Scale, £525 to £820 (subject to revision) with additions for training, experience, etc.

Further particulars and forms of application from the undersigned (stamped addressed envelope).

G. W. R. LINES,
CLERK TO THE JOINT EDUCATION COMMITTEE.

NORTH STREET,
WOLVERHAMPTON. M 114

WOLVERHAMPTON AND STAFFORDSHIRE TECHNICAL COLLEGE.

Principal: C. L. OLD, B.Sc.(Eng.), M.Sc.Tech.

An additional full-time

RESEARCH ASSISTANT is required in the Department of Production Engineering and Management to pursue projects on surface finish, tool wear, mechanics of metal cutting and forming, metrology, automation and in other allied fields. Preliminary training will be given in research principles and methods.

SALARY: £500-£550. Applications from graduates or those possessing other outstanding qualifications should be made on forms obtainable from the undersigned.

G. W. R. LINES,
CLERK TO THE JOINT EDUCATION COMMITTEE.

NORTH STREET,
WOLVERHAMPTON. M 115

FIELD DEMONSTRATING ENGINEER required in Mechanisation Branch of N.C.B.'s Production Dept., with good surface and underground experience as a fitter or mechanic, and a thorough knowledge of mining machinery (especially power loaders), to give practical assistance to collieries in the installation of new mining machines. He will be required to acquaint himself with the machines' construction and method of operation, and to train colliery personnel in their operation and maintenance. The post is based on Stanhope Bretby, Nr. Burton-on-Trent, but duties involve spending considerable time in the coalfields. Appointment (superannuable) according to qualifications and experience, within range (£900-£1100).

Write, with full particulars of age, education, qualifications and experience to NATIONAL COAL BOARD, STAFF DEPT., HOBART HOUSE, London, S.W.1, marking envelope SS/313 before 9th July, 1956. M 117

NOTTINGHAMSHIRE EDUCATION COMMITTEE.

COUNTY TECHNICAL COLLEGE AND SCHOOL OF ART,
CHAUNTRY PARK, NEWARK.

(Principal: A. R. BOWEN, Ph.D., D.Sc.)

APPLICATIONS are invited for the appointment of **GRADE B ASSISTANT LECTURER IN MACHINE SHOP ENGINEERING PRACTICE/TECHNIQUES,** to commence 1st September, 1956, or as soon thereafter as possible. Candidates should have appropriate qualifications and industrial/teaching experience. Salary: Burnham Technical Scale, £525 by £25 to £820 per annum, plus additions for approved qualifications/training, and increments for approved experience.—For forms and further particulars please send foolscap s.a.e. to the PRINCIPAL. Closing date, 6th July, 1956.

J. EDWARD MASON,
DIRECTOR OF EDUCATION. M 173

NORTH LINDSEY TECHNICAL COLLEGE.
KINGSWAY, SCUNTHORPE, LINCS.

Principal: F. C. JONES, B.Sc. (Eng.), A.M.I.Mech.E., A.M.I.E.E.

Applications are invited for the following appointment to commence duties 1st July, 1956, or as early as possible after that date:

LABORATORY STEWARD for general laboratory duties in the Engineering and Building Departments. Previous experience in the preparation and maintenance of this type of apparatus and equipment is essential. Possession of a National Certificate or City and Guilds Certificate in an appropriate subject would be a recommendation. Salary and conditions in accordance with scale £445—£510 per annum. Duties to commence 1st September, 1956.

Apply by letter to the PRINCIPAL at the above address as early as possible giving full details of age, experience and qualifications, copies of two recent testimonials and the names of two persons for confidential reference. M 181

NORTH LINDSEY TECHNICAL COLLEGE.
KINGSWAY, SCUNTHORPE, LINCS.

Principal: F. C. JONES, B.Sc. (Eng.), A.M.I.Mech.E., A.M.I.E.E.

Applications are invited for the following appointments in the Engineering Department:—

Required to commence duties in September, 1956, or as soon as possible thereafter, **ASSISTANT GRADE B** to teach Mathematics, Engineering Science and Engineering Drawing in Ordinary National Certificate and Craft Courses. A degree in Mechanical Engineering or an equivalent qualification, and suitable industrial experience are desirable.

Required to commence duties in September, 1956, or as soon as possible thereafter, **ASSISTANT, GRADE A** to teach Calculations, Science and Drawing in Pre-Senior, Ordinary National Certificate and Craft Courses. A Higher National Certificate in Mechanical Engineering and suitable industrial experience are desirable.

Forms of application and further details may be obtained from the PRINCIPAL at the above address to whom completed applications should be returned as early as possible. M 182

COUNTY BOROUGH OF SMETHWICK EDUCATION COMMITTEE.

JAMES WATT SECONDARY TECHNICAL SCHOOL.

(Head Master: Mr. E. COLLINS, M.A., B.Sc.)

MECHANICAL SCIENCE TEACHER required as soon as possible. Candidates should possess Higher National Certificate, Full Technological Certificate or a university degree.

The school covers the age range 11 to 18 and presents boys for G.C.E. examinations at Ordinary and Advanced levels.

Application forms may be obtained from CHIEF EDUCATION OFFICER, 215, HIGH STREET, SMETHWICK, and should be returned as soon as possible.

E. L. TWYCROSS,
Town Clerk. M 204

The NIGERIAN RAILWAY CORPORATION invite applications for following appointments:—

(A) ASSISTANT ARCHITECT (CAPITAL WORKS).

Salary £875 by £50 to £1675 p.a. plus overseas pay £300 p.a.

QUALIFICATIONS: Candidates should be Registered Architect, preference given to Associate Members of Royal Institute of British Architects. They should have had several years experience covering public buildings, factories, workshops, offices and housing, including layouts for same, also design and detailing of reinforced concrete structures, specifications, and supervision of junior staff.

(B) SENIOR DRAUGHTSMAN (STRUCTURAL) (CAPITAL WORKS.)

Salary: £1150 by £50 to £1450 p.a. plus overseas pay £300 p.a.

QUALIFICATIONS: Candidates should have had wide experience of reinforced concrete structural design, together with experience of steel and general structural design, preparation of working drawings and taking off of quantities. Experience of railway work desirable though not essential.

(C) SENIOR DRAUGHTSMAN (ARCHITECTURAL) (CAPITAL WORKS).

Salary £1150 by £50 to £1450 p.a. plus overseas pay £300 p.a.

QUALIFICATIONS: Duties of post cover preparation of design and working drawings for railway stations, offices, quarters, two and three storey blocks of flats, and similar structures. Ability to prepare Bills of Quantities and Specifications for such works would be an asset.

(D) ASSISTANT ESTATE AND VALUATION OFFICER (OPEN LINES.)

Salary: £875 by £50 to £1675 p.a. plus overseas pay £300 p.a.

QUALIFICATIONS: Candidates must be age 22/30. They must be either (*a*) Corporate Members of Royal Institution of Chartered Surveyors or Chartered Auctioneers' and Estate Agents' Institute or Land Agents' Society or (*b*) have passed a degree or other examinations necessary for obtaining Corporate Membership of one of the foregoing Institutions, or (*c*) have a degree in Estate Management—B.A. Cambridge or B.Sc. London. Candidates admitted under (*b*) and (*c*) will be required to qualify under (*a*) n due course.

Commencing salary in each case depends upon qualifications and experience. Terms of service provide for tours of fifteen months each, seven days full pay leave per month of service, free passages for officer and wife and separate domicile allowance of £75 per annum each in respect of a maximum of two children while in the U.K. or cost of their passages to and from Nigeria if under 18 years of age. Part furnished quarters provided at low rental. Outfit allowance £60 payable on first appointment.

Appointment under (*a*)-(*c*) will be on contract terms only which provide for a gratuity of 20 per cent. of total salary plus overseas pay payable at the end of each tour or on final completion of service Appointment under (*d*) may be either on pensionable or contract terms.

Applications, giving details of experience, qualifications and age, should be addressed to LONDON REPRESENTATIVE, NIGERIAN RAILWAY CORPORATION, 11, MANCHESTER SQUARE, W.1. Closing date 7th July, 1956. M 188

ADMIRALTY PRODUCTION INSPECTORS (UNESTABLISHED) required with experience in either mechanical, electrical, electronic or marine engineering for various places in U.K. Duties involve work in connection with manufacture, inspection, test and installation of equipment in H.M. Ships. Age at least 25, should have recognised apprenticeship, or equivalent training, plus additional relevant experience with industry or government department. They should preferably possess H.N.C. or O.N.C. in Mechanical or Electrical Engineering, or have reached at least an equivalent standard of technical education with qualifications in appropriate subjects. Opportunities may occur later to compete for permanent posts. Inclusive salary scales Grade III (Assistant Production Inspectors), £631 to £761. Entry at minimum of scale at age 26 minus £20 for each year below that age, and plus £20 above that age but not exceeding age 28. Grade II (Production Inspectors), £756 to £898 linked to age 90 minus £20 for each year below that age.—Forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting C 432/6A. G 670

UNIVERSITY OF DURHAM.

KING'S COLLEGE, NEWCASTLE-UPON-TYNE.

The Council of King's College invite applications for a **LECTURESHIP IN MECHANICAL ENGINEERING.**

Applicants should hold an honours degree in Engineering and preferably have had some professional experience since graduation.

The commencing salary will be fixed at a suitable point on the scale, £650 by £50 to £1350, in accordance with the qualifications and experience of the successful applicant. Family allowance and F.S.S.U.

Twelve copies of application, together with the names of three persons to whom reference may be made should be submitted not later than 31st July, 1956, to the undersigned, from whom further particulars may be obtained.

G. R. HANSON,
Registrar of King's College. M 207

THE BRITISH SOCIETY FOR RESEARCH IN AGRICULTURAL ENGINEERING has vacancy for

JUNIOR ENGINEER in Instrumentation Department. Inter.B.Sc., H.N.C. or equivalent qualification essential; drawing office experience and of design of small mechanisms or in testing materials an advantage.

Salary scale: £429 at 21 to £706 with starting salary limited to £559 at 26 or over.

Application forms from SECRETARY, N.I.A.E., WREST PARK, SILSOE, BEDS. M 203

THE UNIVERSITY OF MANCHESTER.

Applications are invited from graduates in Physics, Chemistry, Metallurgy, Biology or Engineering for the post of

ASSISTANT LECTURER IN DENTAL MATERIALS. The person appointed will be concerned with work on the physical properties of dental materials. There is a wide scope for research in this field and ample facilities are available. Salary on a scale £550 by £50 to £650 per annum with membership of F.S.S.U. and Children's Allowance Scheme.—Applications should be sent not later than June 30th, 1956, to the REGISTRAR, THE UNIVERSITY, MANCHESTER, 13, from whom further particulars and forms of application may be obtained. L 709

APPOINTMENTS OPEN.

SENIOR CHEMICAL PLANT DRAUGHTSMEN.

A PROMINENT Chemical Manufacturer, operating in the East London area, has vacancies for men experienced in the layout and detailing of chemical plant installations, including pressure vessels, pipework, steelwork, and associated mechanical items.

THE WORK is of a varied nature, covering new projects in the main in which speed is an essential factor.

THE COMPANY is just embarking on a substantial scheme of expansion involving the development of a large new factory site.

APPLICANTS should have a good mechanical background with technical qualifications to Ordinary Higher National Certificate level or higher.

THE SALARIES paid will be in accordance with A.E.S.D. rates or better.

THE POSTS are permanent and pensionable with good working conditions, five-day week, canteen and sports facilities.

APPLY INITIALLY IN WRITING, giving full details of training and career, age, etc., to BOX M 122, Offices of ENGINEERING.

DETAILERS, EXPERIENCED in reinforced concrete, preferably with some design knowledge, required for London Professional Office. EXPERIENCE of steelwork an advantage but not essential. The work is varied and offers scope for initiative and advancement. The positions are permanent and are particularly suitable for those hoping to gain further experience. Five-day week.—Apply stating full details and salary required to FARMER AND DARK, ROMNEY HOUSE, TUFTON STREET, S.W.1. M 123

A large industrial company in the South of England is engaged on a programme of expansion running into several million pounds. The programme not only includes extensions to existing plants, but provides also for increased activity into relatively novel fields. The individual projects vary in character and involve all types of engineering from light precision machine work to heavy process equipment, and include all the planning, layout and procurement associated with the design and erection of large manufacturing units.

To help this programme forward, the company proposes to engage

A FEW FIRST CLASS MEN TO STRENGTHEN ITS ENGINEERING DIVISION. Applications are invited from men holding First or Second Class Honours degrees in Mechanical or Chemical Engineering with some years of industrial experience following graduation. In addition to technical competence, the organization requires men of energy and initiative with good personal qualities. The Company would also be glad to hear from men who are graduating this year, who are free from National Service and who served a recognised apprenticeship.

Attractive starting salaries will be paid and those appointed should progress fairly rapidly to an initial salary ceiling of around £1,300 per annum. Beyond this there is plenty of scope for progressive remuneration. The Company works a 5-day week in pleasant surroundings, and pension and profit sharing schemes are in operation. Special mortgage facilities can be granted towards house purchase, and assistance is also available towards removal expenses.—Apply to BOX M 124, Offices of ENGINEERING.

SENIOR MECHANICAL ENGINEER required by Major Oil Company for service in MIDDLE EAST OILFIELDS, age not over 45. Applicants must possess degree in Mechanical Engineering or equivalent and have had ten years general experience in operation and maintenance of mechanical equipment used in oilfields such as internal combustion engines (petrol, gas, diesel), pumps, compressors, steam plant, ice plants and water filtration plants, etc. Two years of above period must have been spent in an organisation where a planned maintenance system is in operation. Two-year tour in first instance and salary not less than £2650 p.a. Married accommodation and free family passages available.—Write, giving age, brief details of career and asking for application form to BOX EG.370, c/o 191, GRESHAM HOUSE, E.C.2. M 129

BRITISH OXYGEN GASES LIMITED require the services of a

JUNIOR ELECTRICAL DRAUGHTSMAN for work in connection with electrical circuits for power and lighting installations and plant layout in factories. No actual experience of this work is necessary but candidates must have the ability to develop and acquire experience in this field.—Write, stating full particulars to PERSONNEL MANAGER, BRIDGEWATER HOUSE, CLEVELAND ROW ST. JAMES'S, LONDON, S.W.1. M 104

To meet a big new programme of development, a large organization with Headquarters near London, urgently requires

MORE DRAUGHTSMEN. In particular, men are wanted who are experienced in work associated with chemical plant, e.g., pipework, vessels, heating and ventilating, drying, powder conveying and packing. Mechanical draughtsmen are also wanted, since the programme includes development work in novel processes which are essentially mechanical in nature. In addition, there are vacancies for men with plant instrumentation knowledge. Attractive starting salaries will be paid, and pension and profit sharing schemes are in operation. Special mortgage facilities can be granted towards house purchase and assistance is also available towards removal expenses. —Apply in full to BOX M 138, Offices of ENGINEERING.

CHEMICAL ENGINEER required as Manager for Chemical Plant in S.W. Lancs. B.Sc.Chem., M.I.Chem.E., or equivalent qualifications essential. Age up to 45 years. Salary commensurate with experience.—Apply, giving full details, to BOX M 136, Offices of ENGINEERING.

ENGINEER required for HYDRAULIC INJECTION MOULDING AND DIECASTING machines to be solely responsible for installation, setting to work and servicing throughout United Kingdom.

Must have considerable experience of high-pressure oil systems and machine erection.—Apply BOX M 134, Offices of ENGINEERING.

THE ENGLISH ELECTRIC CO., LTD.

Atomic Power Department, Whetstone,

has vacancies for:—

(a) **INSTRUMENTATION AND CONTROL ENGINEERS**

with knowledge and experience of the application of instrumentation and control techniques on large scale research equipment, with particular reference to the measurement, transmission, indication and recording of pressures, temperatures, flows, automatic gas sampling and electrical apparatus for control and display operations. Applicants should be Corporate Members of a recognised Professional Institution.

(b) **MANUFACTURING AND CONSTRUCTIONAL OPERATION ENGINEERS**

with either mechanical or electrical engineering knowledge in initiating, control and programming of manufacturing and constructional operation on medium and heavy engineering plant. Applicants should be Corporate Members of a recognised Professional Institution. Experience on plant layout, project engineering and site works will be an advantage.

Apply to DEPT. C.P.S., 336/7, STRAND, W.C.2, quoting Ref. 1816.

M 169

DESIGN ENGINEERS required for small Electro-mechanical mechanisms and Measuring instruments —tachometers, recorders and control devices, preferably with experience in the Instrument field.

Good prospects and working conditions.

Apply: SMITHS INDUSTRIAL INSTRUMENTS LTD., NORTH CIRCULAR ROAD, LONDON, N.W.2. M 172

CIVIL ENGINEER wanted for Consulting Engineers' London Office.

Applicants should be fully qualified and have considerable experience in the design of docks, jetties and marine works.

Five-day week, pension scheme.

Apply with full particulars of age, qualifications and experience, to BOX NO. 103, c/o CHARLES BARKER & SONS LTD., 31, BUDGE ROW, LONDON, E.C.4. M 167

TECHNICAL MANAGER required to be responsible for design and development department of a Company producing Printing Machinery. Applicants must be capable of designing such products and generally supervising a design department. Applicants should have served a recognised engineering apprenticeship, have an engineering degree and wide experience of mechanical engineering design if not of printing machinery. This is a senior executive position, carrying a high salary, and offers every opportunity to the right man.—Applications, giving full particulars of education, qualifications, experience and age, should be addressed to BOX M 121, Offices of ENGINEERING.

WORKS MANAGER

FOR

AERO ENGINE RESEARCH

AND

DEVELOPMENT PROGRAMME

A well-known Company invites applications from Engineers of suitable experience and proved administrative ability for the above appointment.

Applicants who should be under 45 must be well qualified and capable of undertaking full responsibility for all manufacturing departments and workshops, undertaking an interesting and expanding experimental programme of national importance.

The position provides excellent prospects for advancement along with a good salary and Pension Scheme to a man possessing first-class leadership and initiative.

Applications, which will be treated in strict confidence, should give full details of experience, qualifications, etc., and be addressed to BOX AC.20148, SAMSON CLARKS, 57-61, MORTIMER STREET, LONDON, W.1. M 170

SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN required for interesting work on large chemical plant installations. Experience in this type of work is desirable but not essential, applicants with general mechanical engineering experience will be favourably considered. The posts offer excellent opportunities with generous salaries commensurate with experience and ability. Offices situated in the N.W.1 London area. Five-day week and superannuation scheme. Applications, which will be treated in confidence, should give previous experience and qualifications, and be addressed to the CHIEF DRAUGHTSMAN, LAPORTE CHEMICALS LIMITED, CLIFTON HOUSE, EUSTON ROAD, LONDON, N.W.1. G 664

AERO ENGINE CONTROL SYSTEM.

ENGINEERS are required for a newly formed department dealing with various theoretical aspects of aero engine control problems. Experience of servo mechanism analysis and gas turbine engine performance investigation is desirable.—Applications quoting END to TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY. G 658

DESIGN DRAUGHTSMEN. The British Drug Houses Ltd. invite applications from suitably qualified men for interesting work in their Engineers Drawing Office, on special machines and plant layouts for the Light Chemical Industry. Higher National Certificate in Mechanical Engineering and previous experience in this industry desirable but not essential. Men of mature age with suitable training and experience would be considered. Five-day week. Pension and Profit Sharing Schemes.—Write stating age, experience and salary required to STAFF MANAGER (REF. B8945), GRAHAM STREET, CITY ROAD, N.1. L 918

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DRAUGHTSMEN to design in aluminium for sales development. Must possess Higher National Certificate in Mechanical Engineering. Location Banbury. Good working conditions and pleasant surroundings. Attractive starting salaries offered up to £800 p.a. with prospects of promotion from drawing board. Pension plan in operation. Send brief details of qualifications and experience to NORTHERN ALUMINIUM CO., LTD., BUSH HOUSE, ALDWYCH, LONDON, W.C.2. G 562

A vacancy has occurred for a

SENIOR DESIGN DRAUGHTSMAN

This is an opportunity for entering an unusual and specialised field of mechanical handling. Excellent salary. Luncheon vouchers. Pension scheme. 5-day week. Christmas bonus. Occasional opportunities may occur for short visits abroad.—Write, giving details of age, experience, and salary required, to:

BRITISH ROPEWAY ENGINEERING CO., LTD.,
PLANTATION HOUSE, MINCING LANE,
LONDON, E.C.3.

M 183

SENIOR JIG AND TOOL DRAUGHTSMEN required for Tool Design on

(a) Small I.C. Engine components.
(b) Fuel Injection and Hydraulic Control Mechanisms on a production basis.

Applicants should have experience in these or similar fields.

Pleasant working conditions. Generous salary commensurate with qualifications demanded. Attractive pension scheme. Comprehensive welfare facilities.

Apply to CHIEF PERSONNEL OFFICER, BRYCE BERGER WORKS, STAINES, MIDDX. G 660

ENGINEERS are required by the Group Engineering Division of the REED PAPER GROUP who will be capable after training of carrying through complete engineering projects connected with paper mills from the development to the final construction stage. Paper mill experience an advantage, but candidates must be technically qualified in engineering. Assistance is offered with housing, excellent working conditions and salary, non-contributory pension fund. Applications must be submitted in writing stating age, qualifications and experience to GROUP PERSONNEL OFFICER, ALBERT E. REED & CO. LTD., LARKFIELD, Nr. MAIDSTONE, KENT, quoting reference E.G.E./2. M 90

DRAUGHTSMEN

GENERAL LIGHT ENGINEERING

with ORDINARY NATIONAL CERTIFICATE as minimum qualification required by

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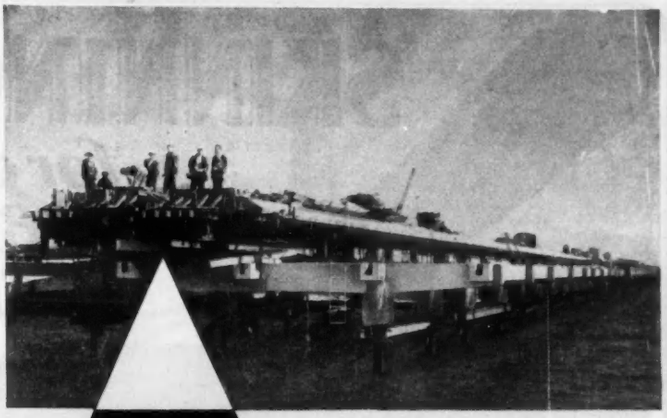
Research Laboratory,
ASSOCIATED ELECTRICAL INDUSTRIES LIMITED
Aldermaston Court,
Aldermaston, Berkshire.

M 142

Classified Advertisements continued on Page 113



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The photograph shows the final section of the 3,000 foot main trunk way of the oil jetties at Kwinana Oil Refinery, Western Australia—which will be the largest refinery in Australia on completion. The Lee-McCall system of prestressed concrete construction was employed in the construction of these jetties.

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PC 29

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The above gauges are available in various designs to meet individual requirements, and a wide range of measuring instruments can be supplied for indicating or recording static strains.

Write for lists 210 and 210A, which give full particulars of all the above gauges and associated apparatus.

Gauges are available in the following types :

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(b) *Araldite bonded, wire wound on Araldite backing. Maximum temperature 80° C. Resistance 50 Ω and 100 Ω.*

(c) *Bakelite bonded, wire wound. High temperature 200° C. Resistance 250 Ω.*

(d) *Foil gauges.*

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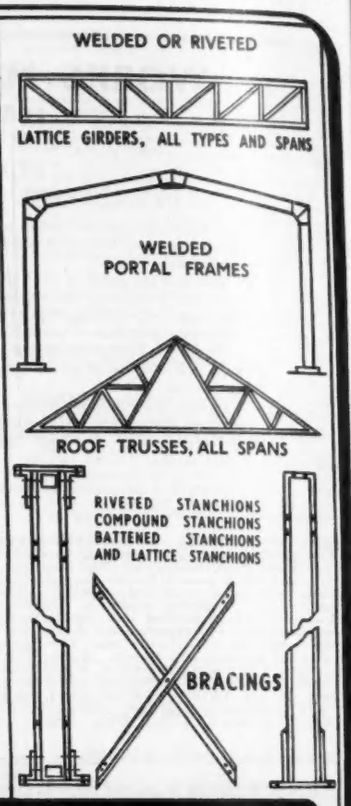

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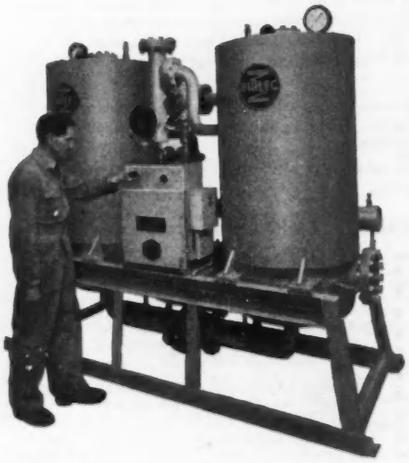
BIRLEC LECTRODRYERS are fully automatic (essential for dispersed sites) and low in running and maintenance costs. Easy to install and operate, they are non-chemical in principle.



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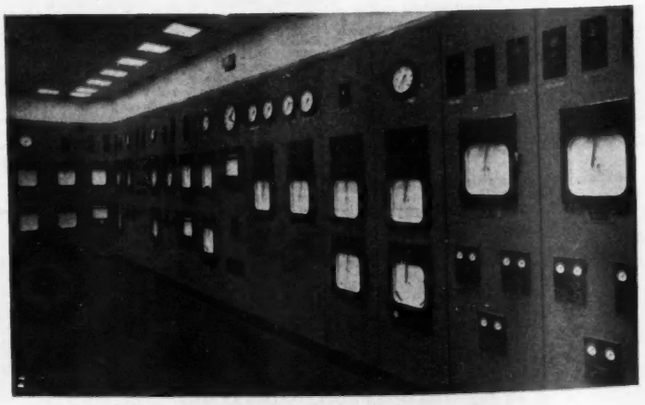

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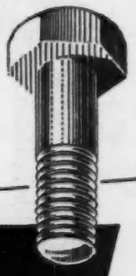

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★ *Illustrated leaflet giving full details of the Deoxo Indicator forwarded on request. Technical representatives are always available for consultation and advice.*

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You observe that the voltmeter on the incoming supply fluctuates wildly; and that the one on the outgoing supply is quite steady. Look behind the panel and you will see how the trick is done. You will find there an Austinlite series voltage regulator. This regulator was designed in the first place to do a specific job—for the G.P.O.—because nothing quite good enough existed. Special equipment developed in this manner can be well made at a reasonable cost. Perhaps you have at some time searched for equipment which seemed unobtainable in the right quality and at the right price?

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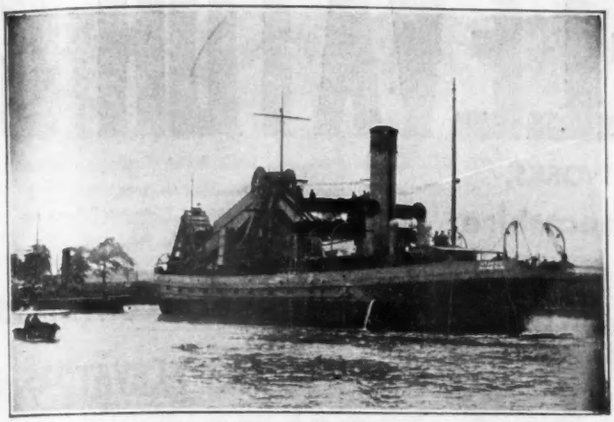

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Dimensions: 258 ft. × 20 ft. Hopper capacity 2,000 tons.
Speed loaded: 9½ knots. Dredging capacity per hour: 1,000 tons.

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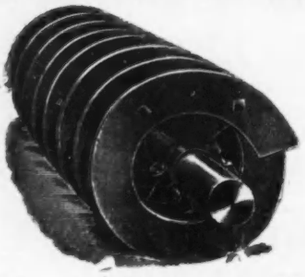

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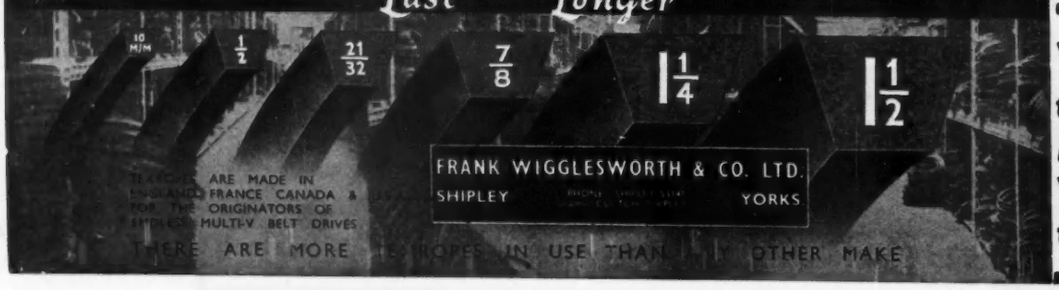

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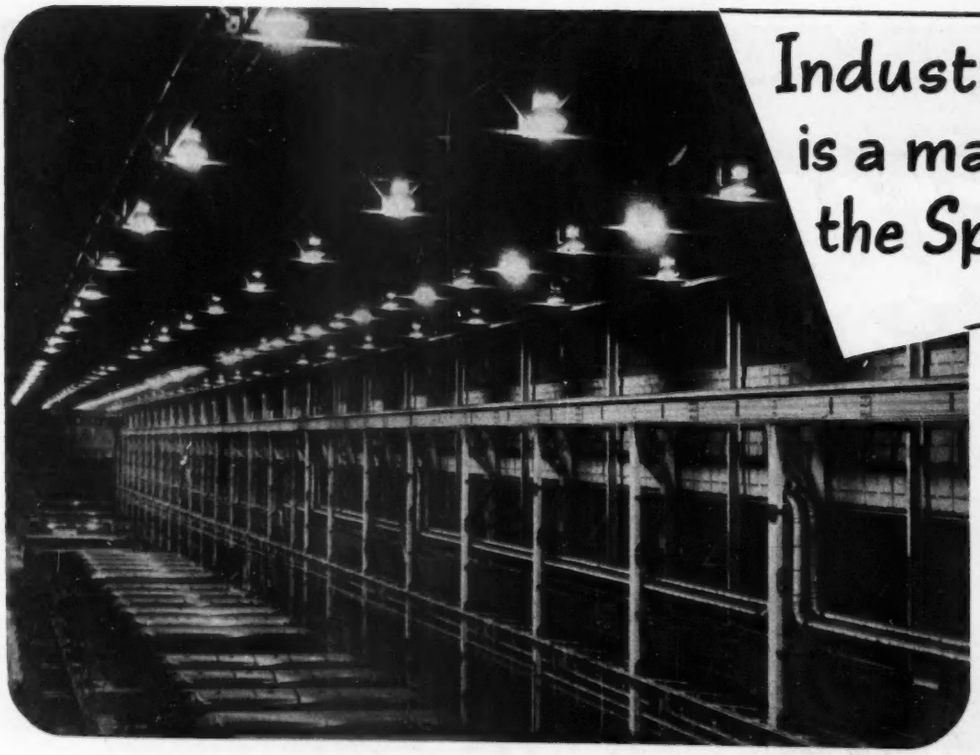

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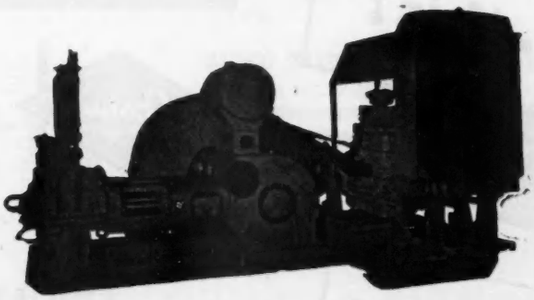

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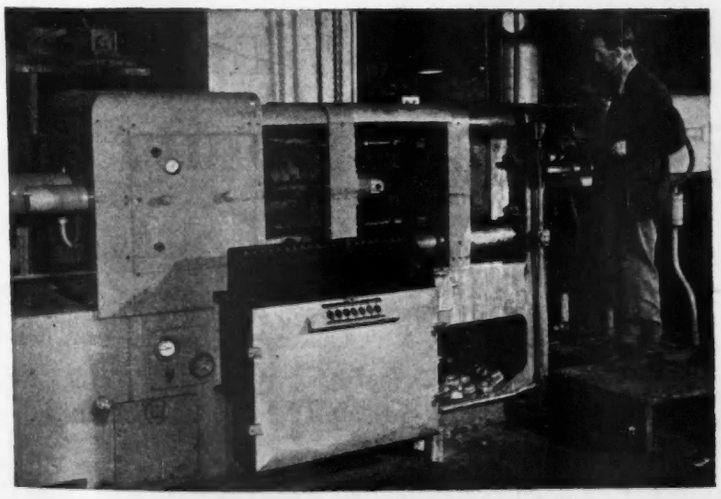

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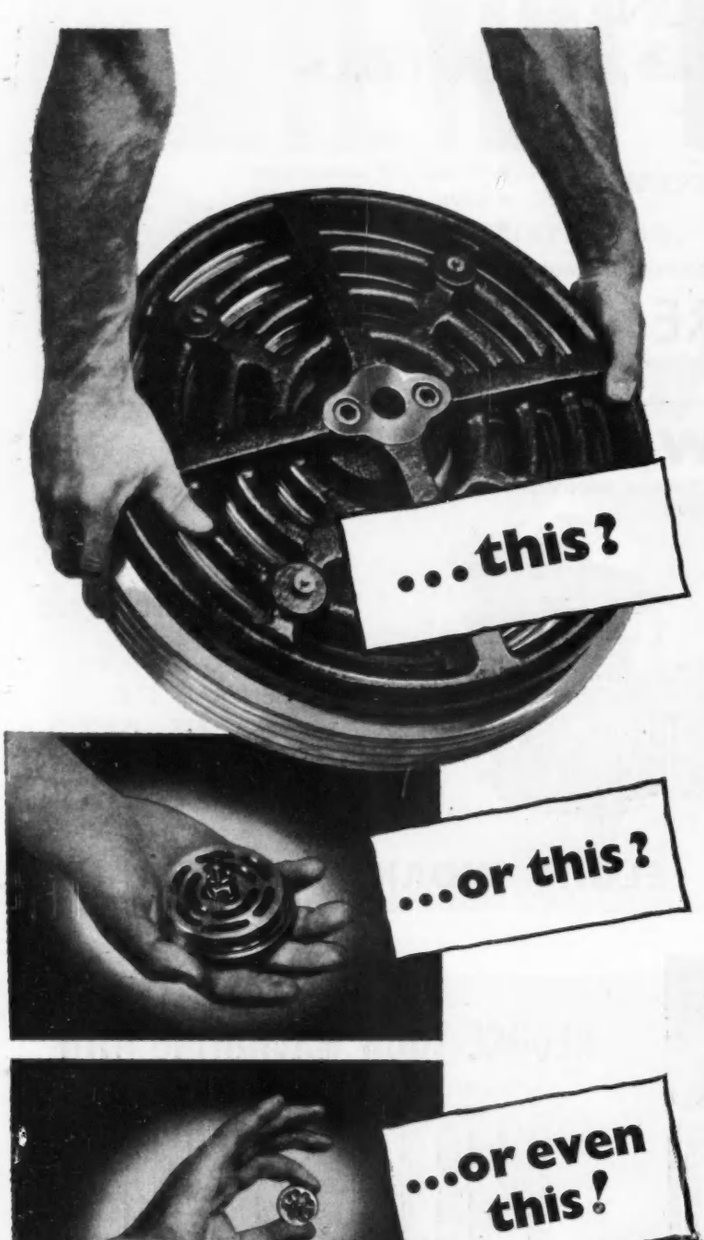

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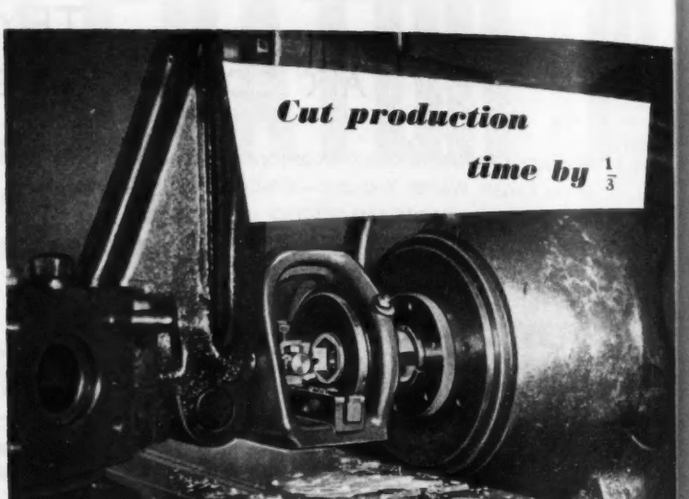

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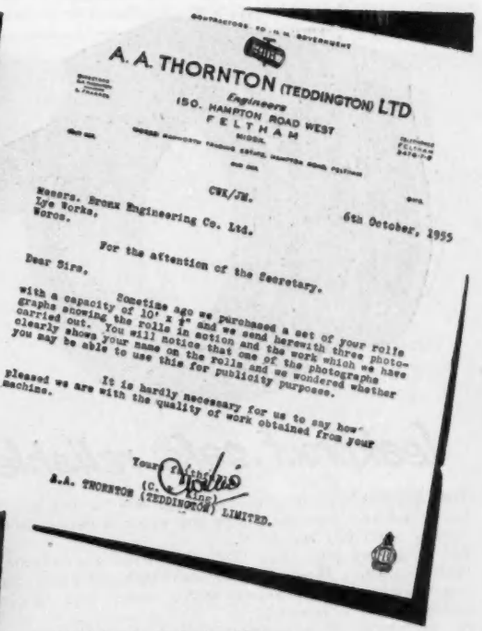

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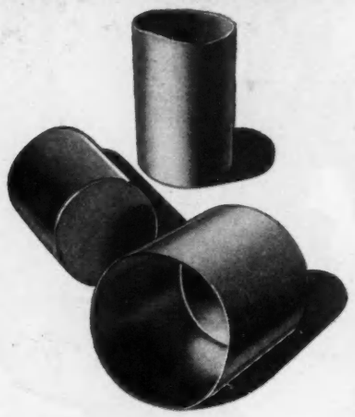

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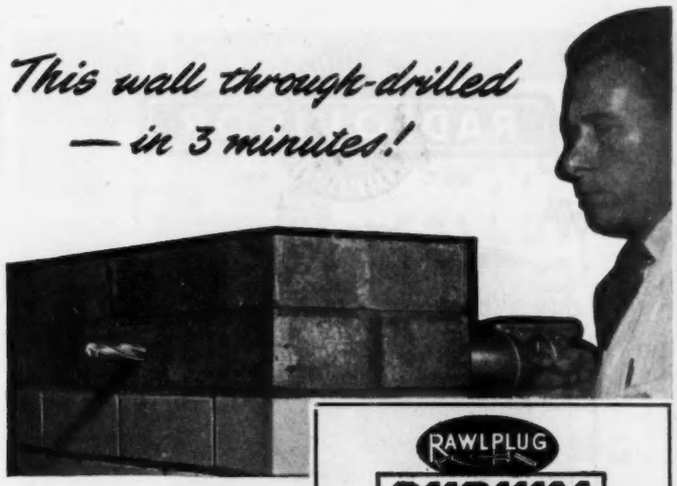

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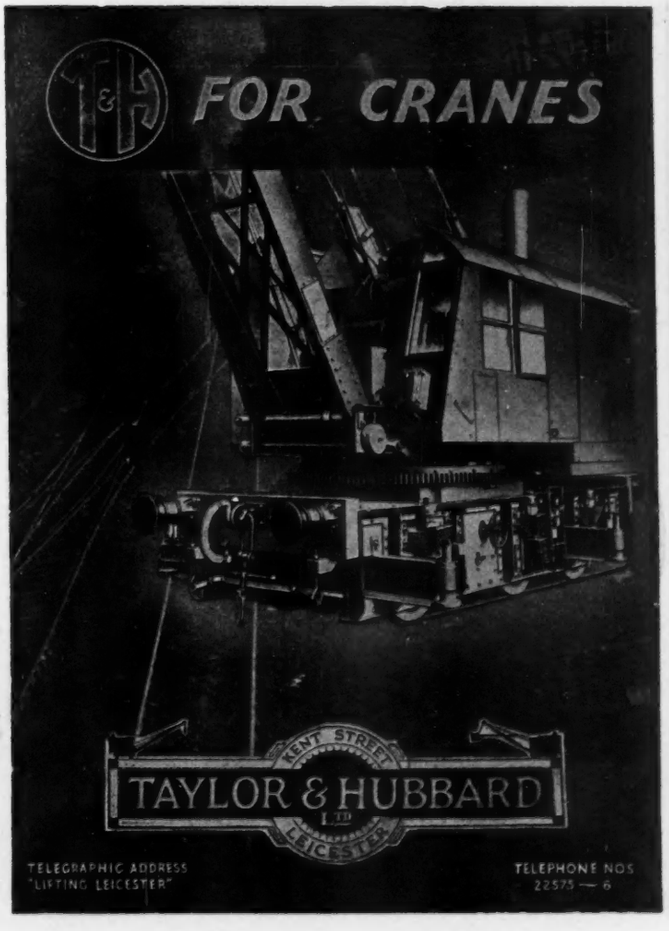

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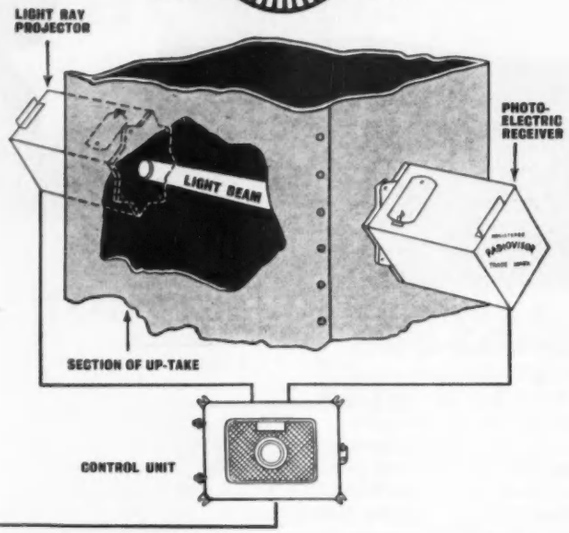

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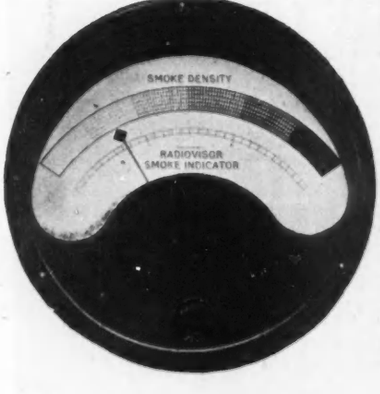

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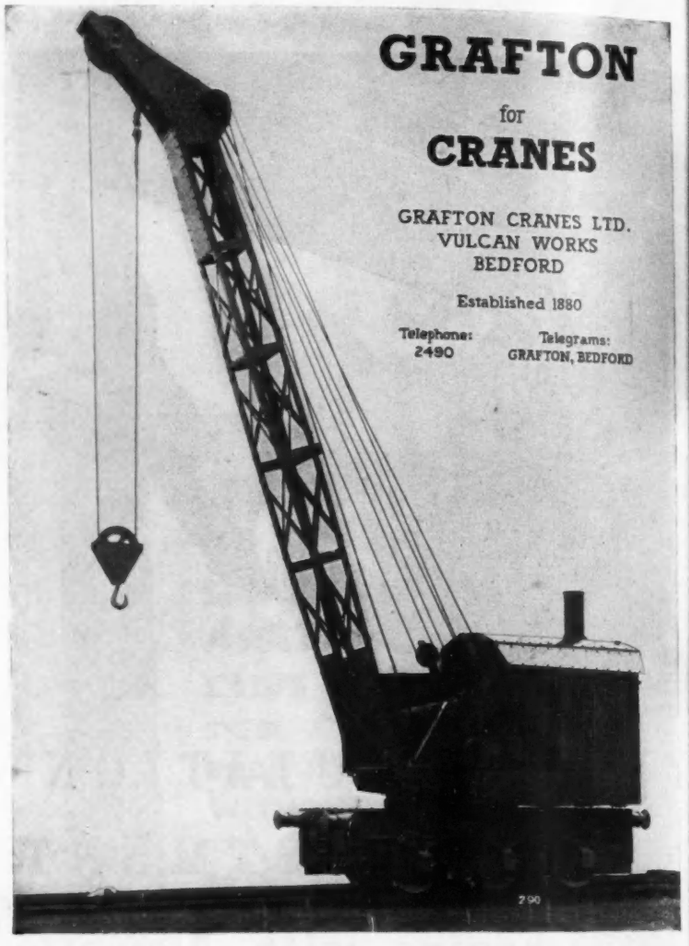

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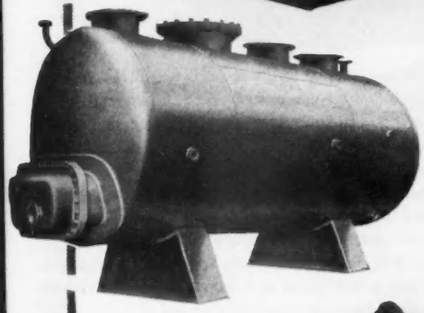

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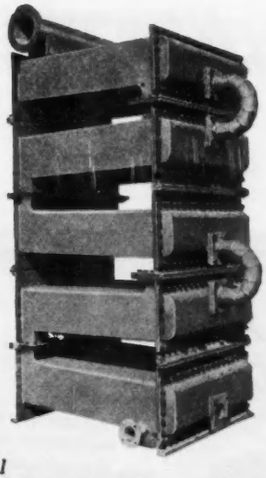

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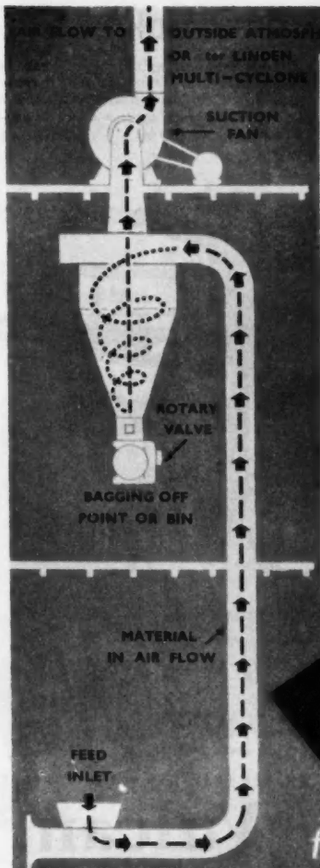

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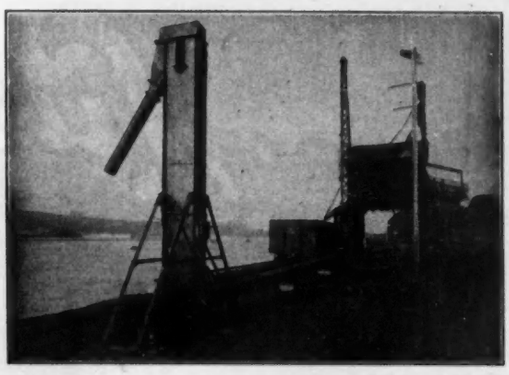

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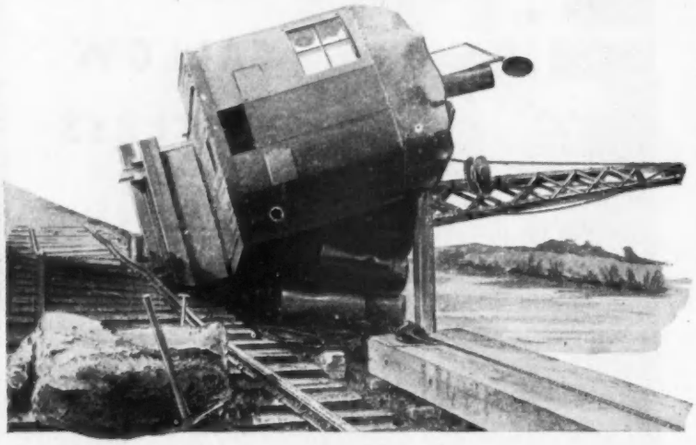

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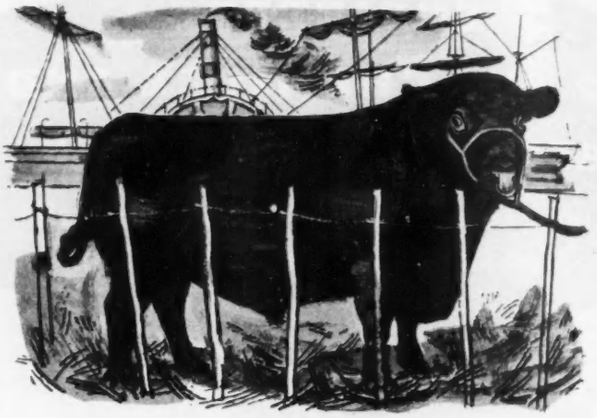

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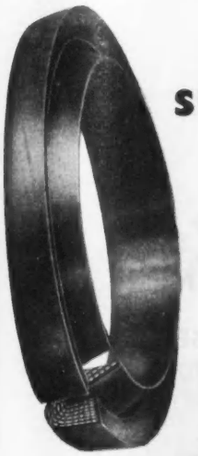

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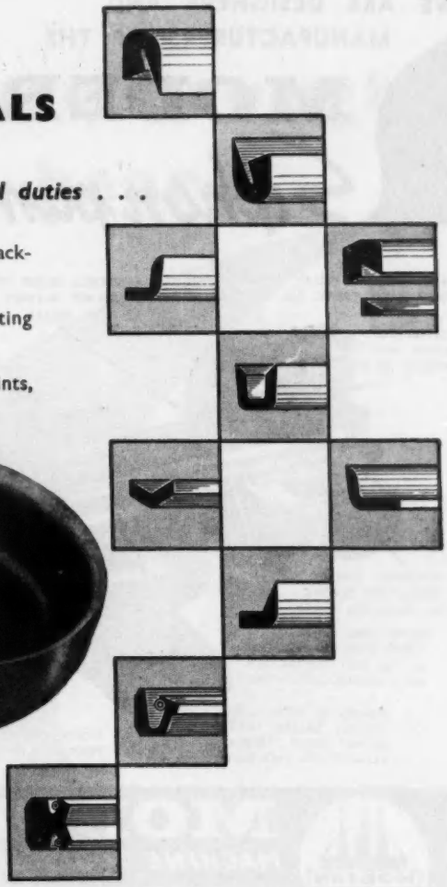

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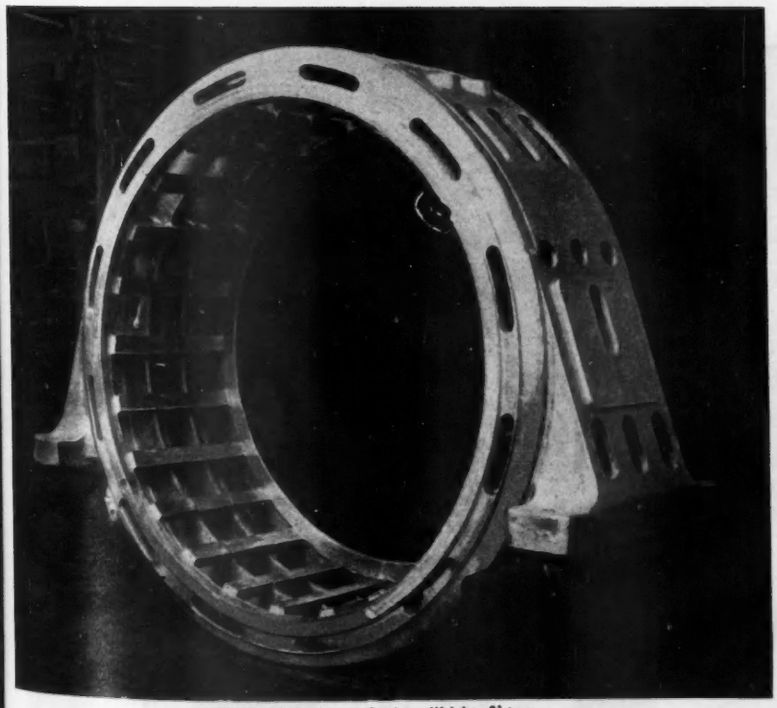

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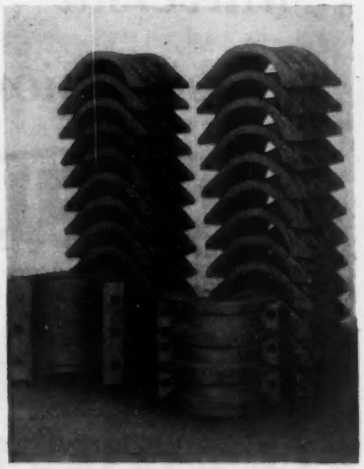

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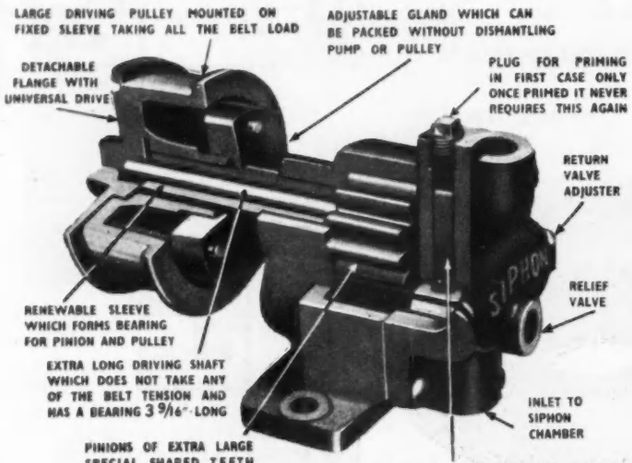
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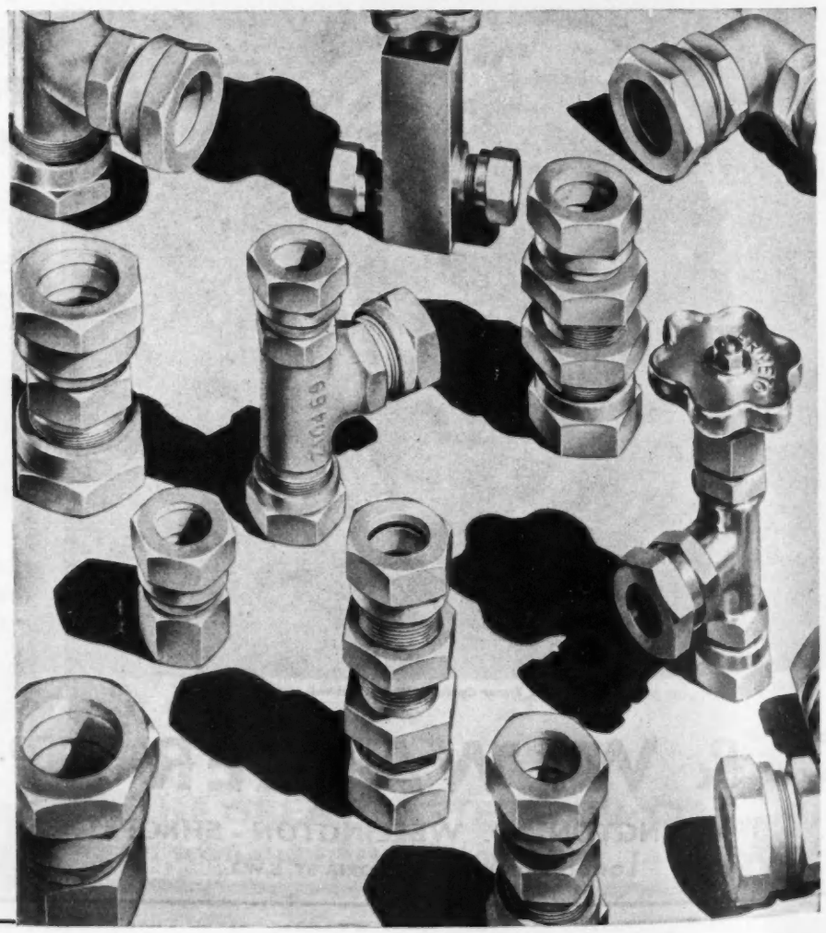

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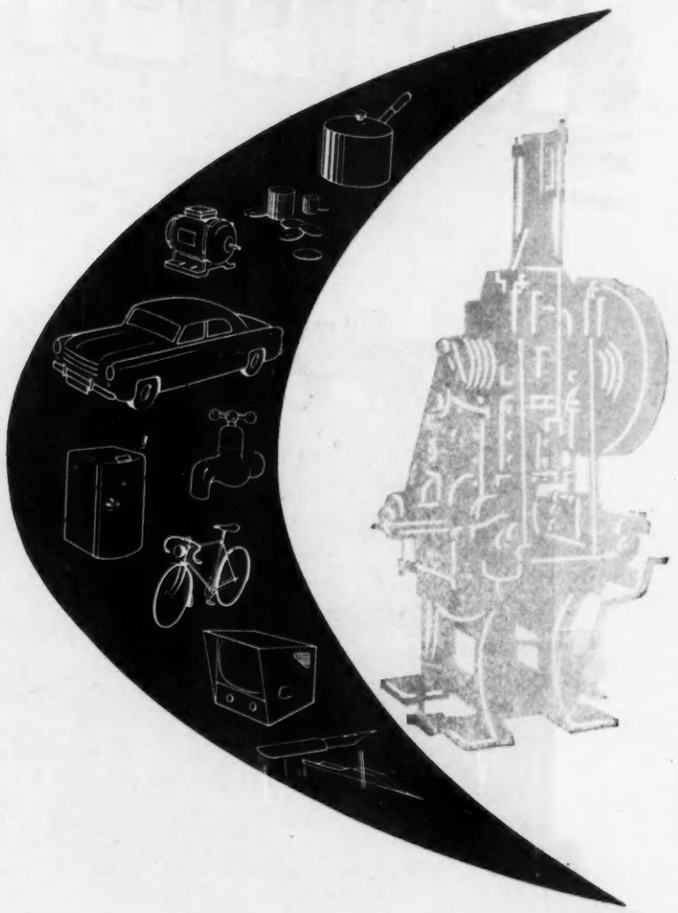

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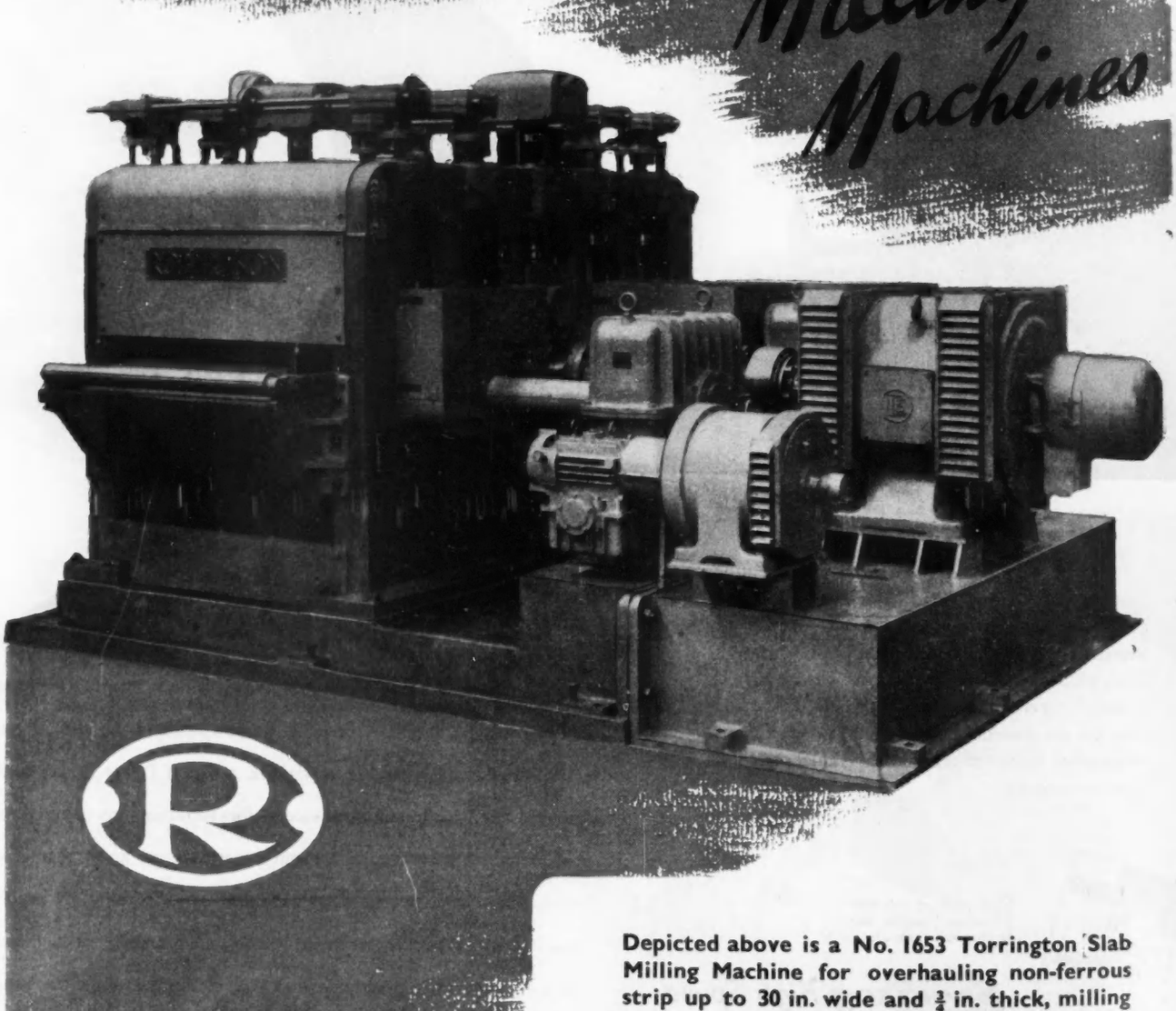

Depicted above is a No. 1653 Torrington Slab Milling Machine for overhauling non-ferrous strip up to 30 in. wide and ¾ in. thick, milling one face at a time.

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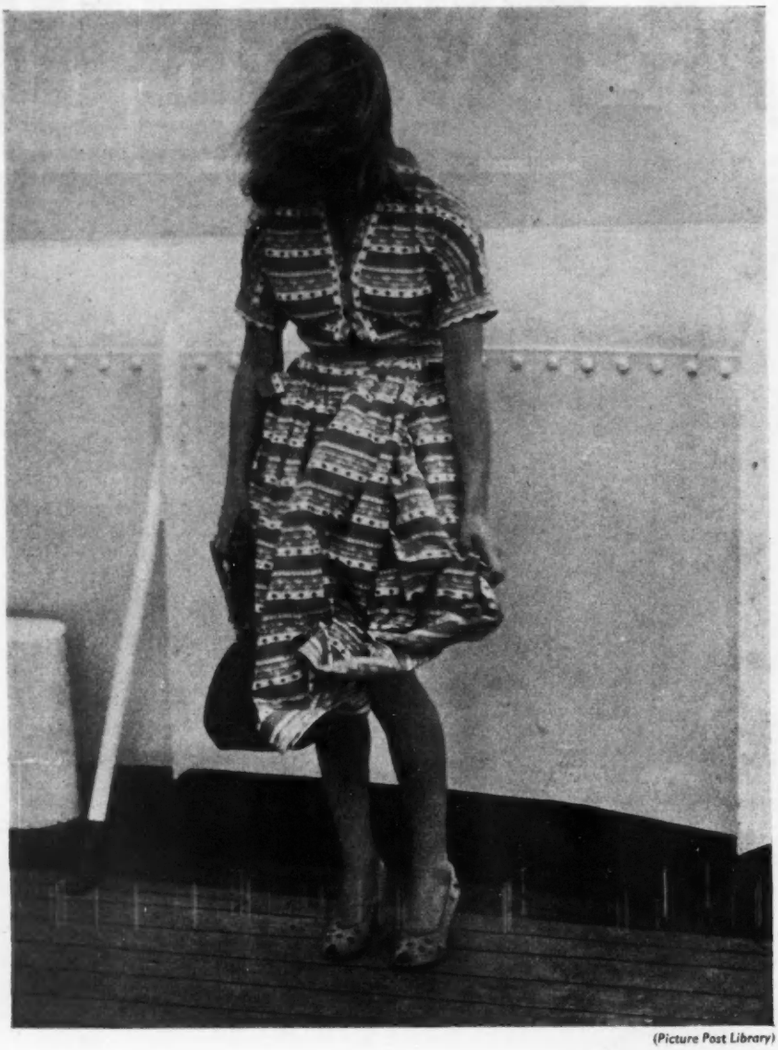

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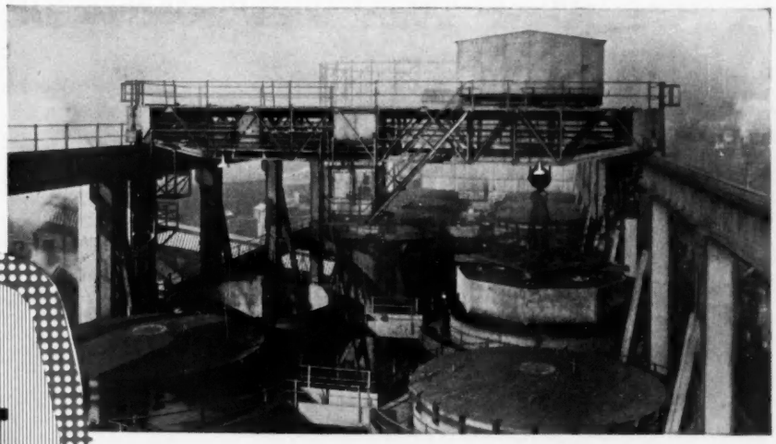

60-ton Babcock overhead travelling crane serving tower purifiers at Neepsend Gas Works; East Midlands Gas Board.

Main Contractors: Newton Chambers & Co. Ltd.

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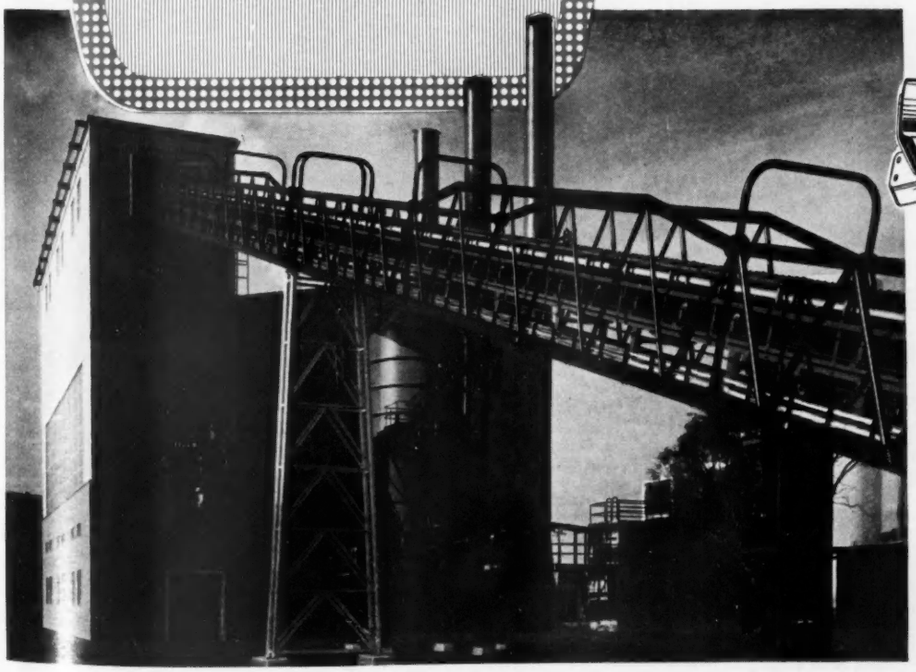
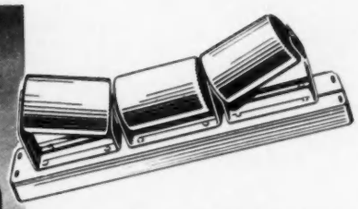
If you want to unload, crush, screen and bunker coal at 1,000 tons an hour, to tipple a railway wagon in 30 seconds, to pump water-borne ash for a couple of miles, or to handle difficult " wet " materials such as slurry . . . and require plant that will keep on doing it all round the clock, economically and with a minimum of maintenance, Babcock & Wilcox Ltd. can almost certainly provide the scheme, and the plant you need.





Babcock self-lubricating conveyor idlers.

Boiler house of the H. J. Heinz Co. (Pty.) Ltd. factory, Victoria, Australia, showing the Babcock coal conveyor and " Hydrovac " dust handling Cyclone serving the Babcock boiler plant

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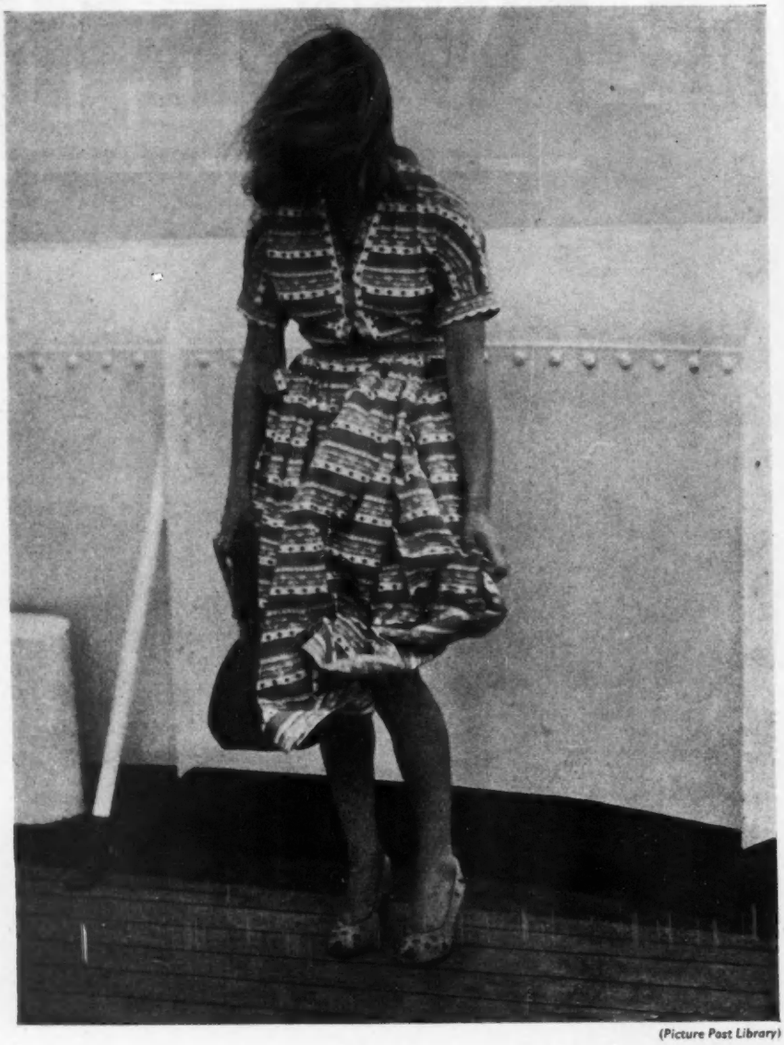

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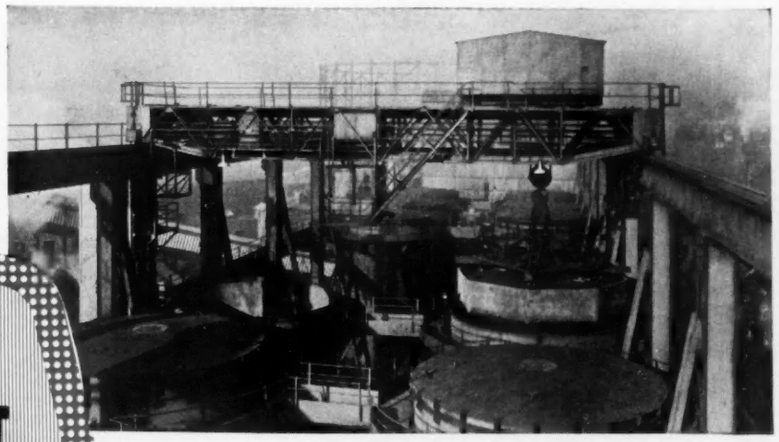

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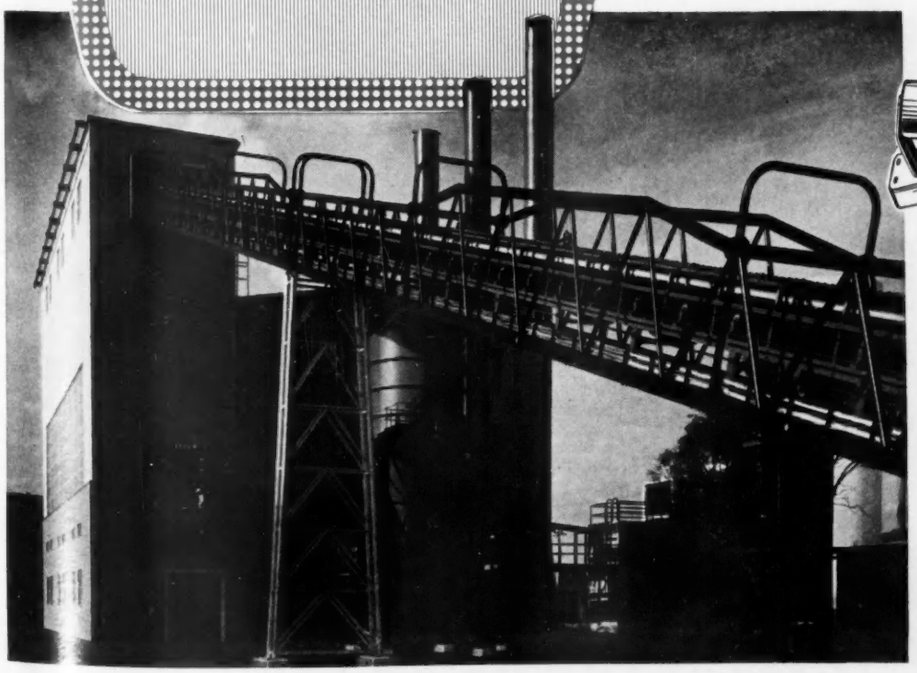

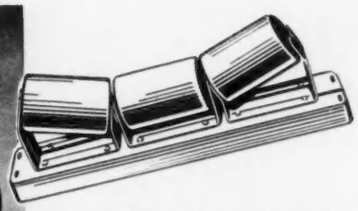

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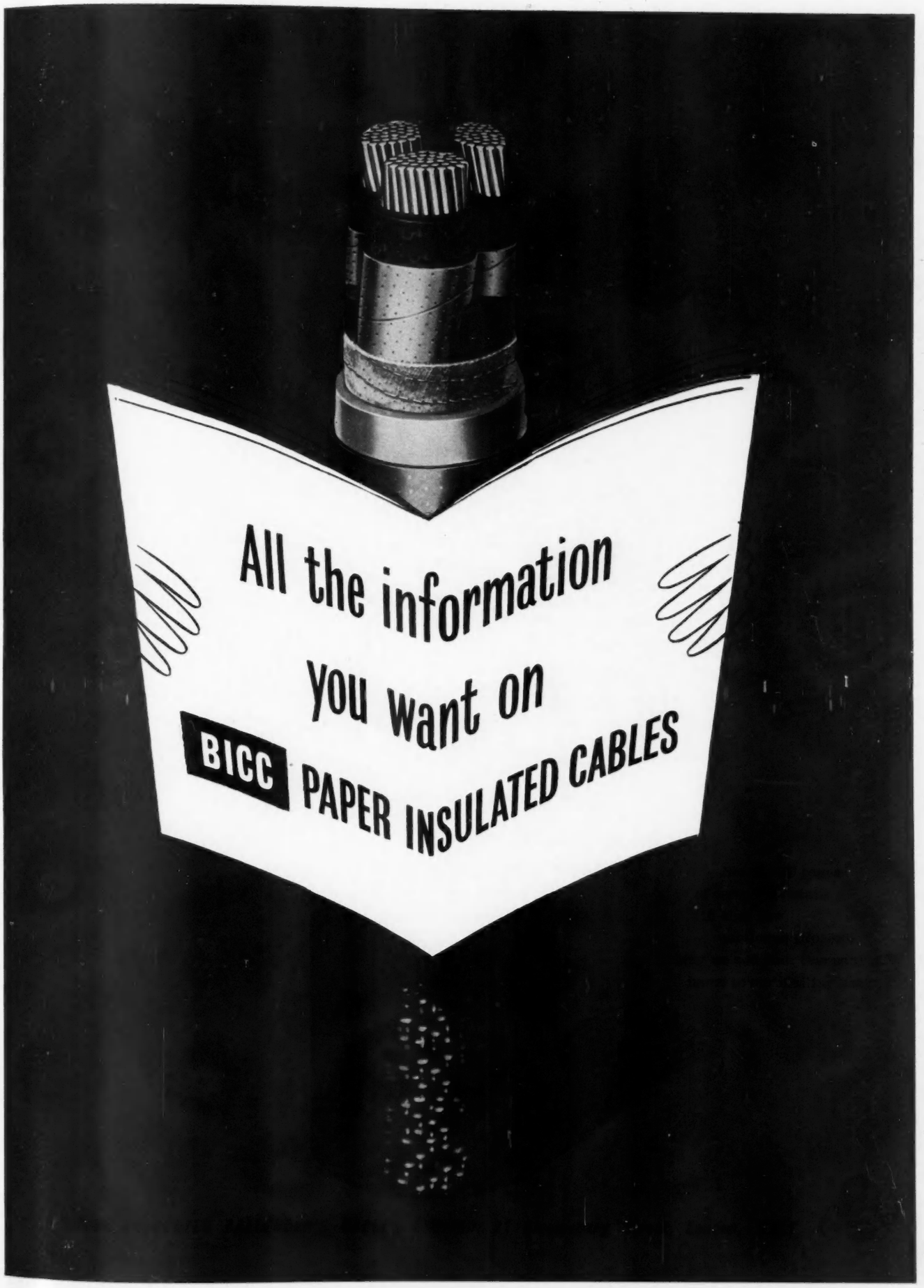
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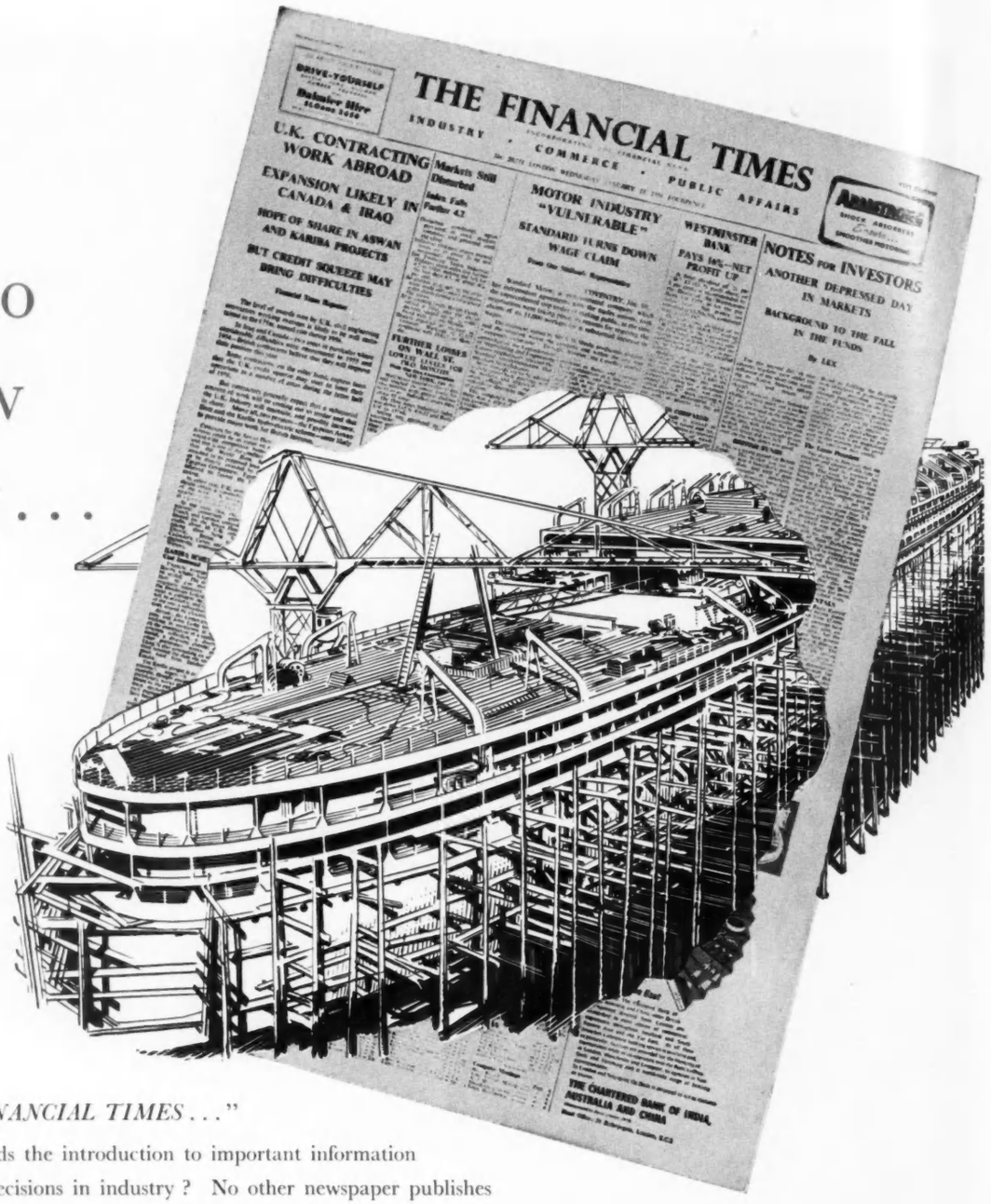
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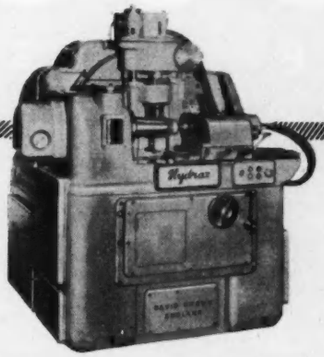
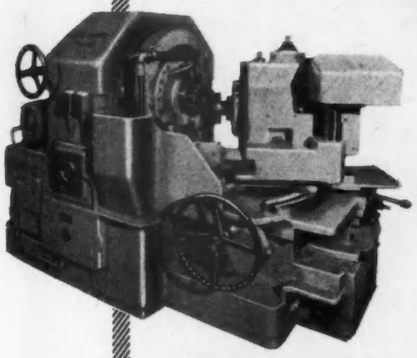


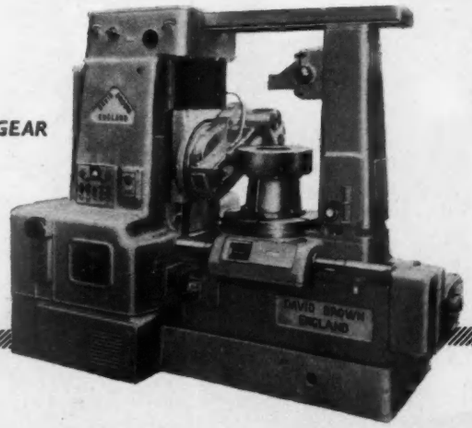
NO. 7 HYDRAX PRODUCTION GEAR HOBBING MACHINE

NO. 14 HYDRAX PRODUCTION GEAR HOBBING MACHINE



B16 SPIRAL BEVEL AND HYPOID GENERATOR

S6H PRODUCTION GEAR SHAVING MACHINE



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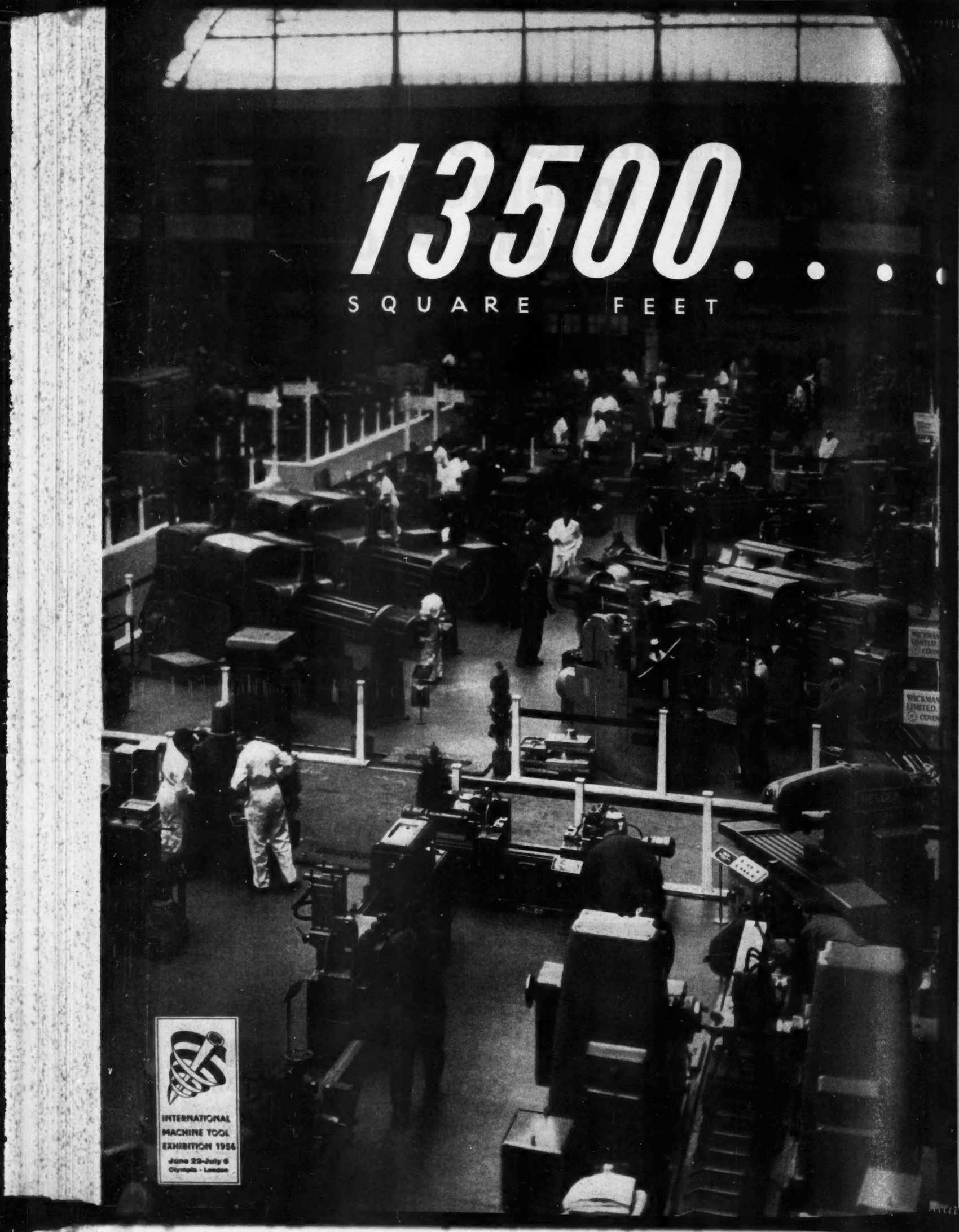
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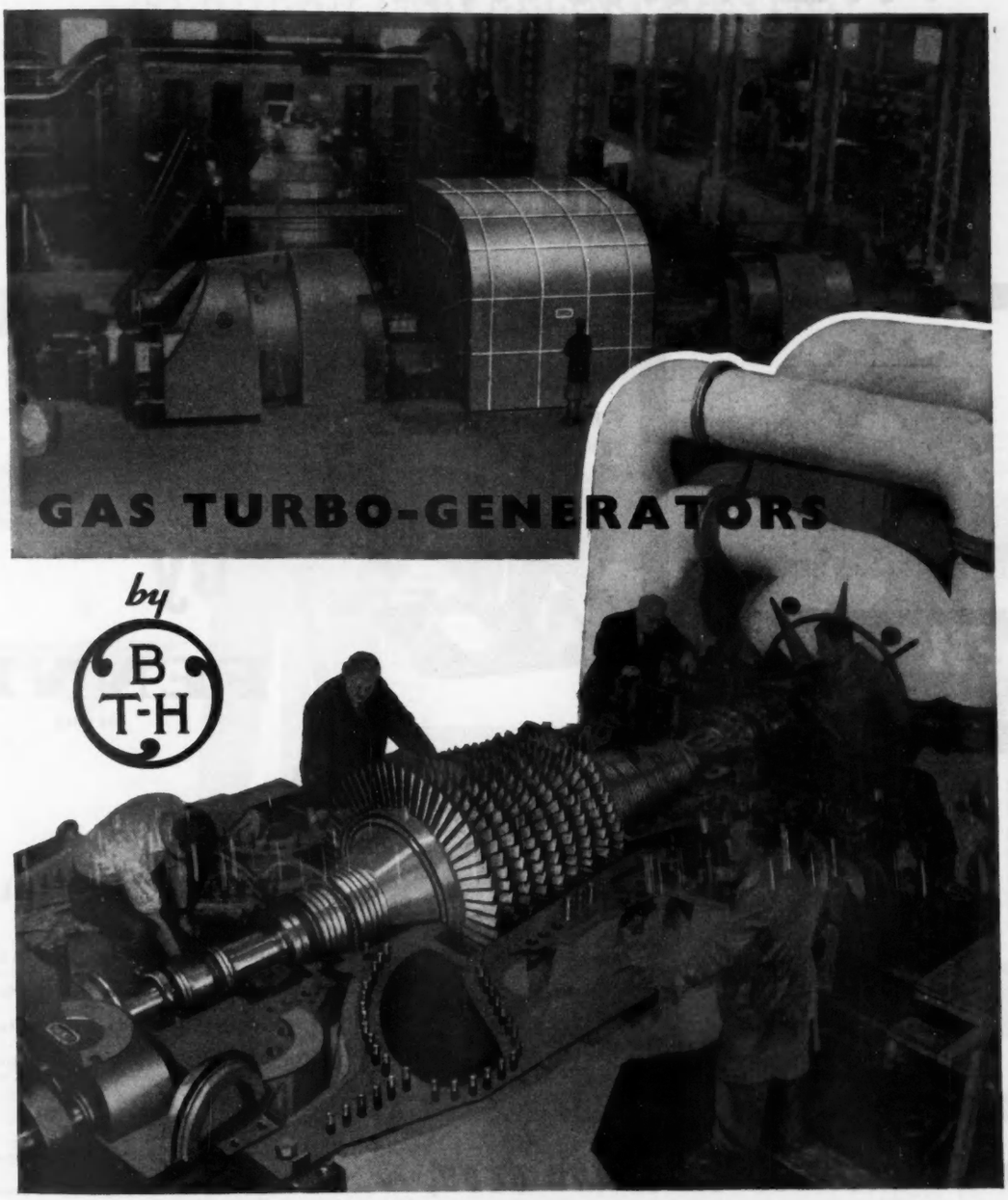

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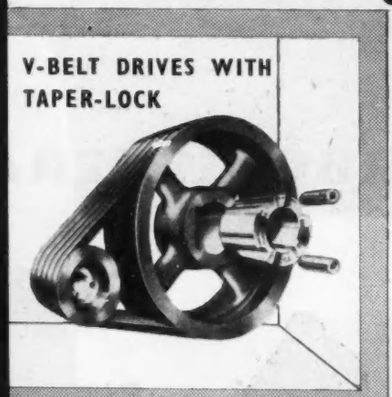

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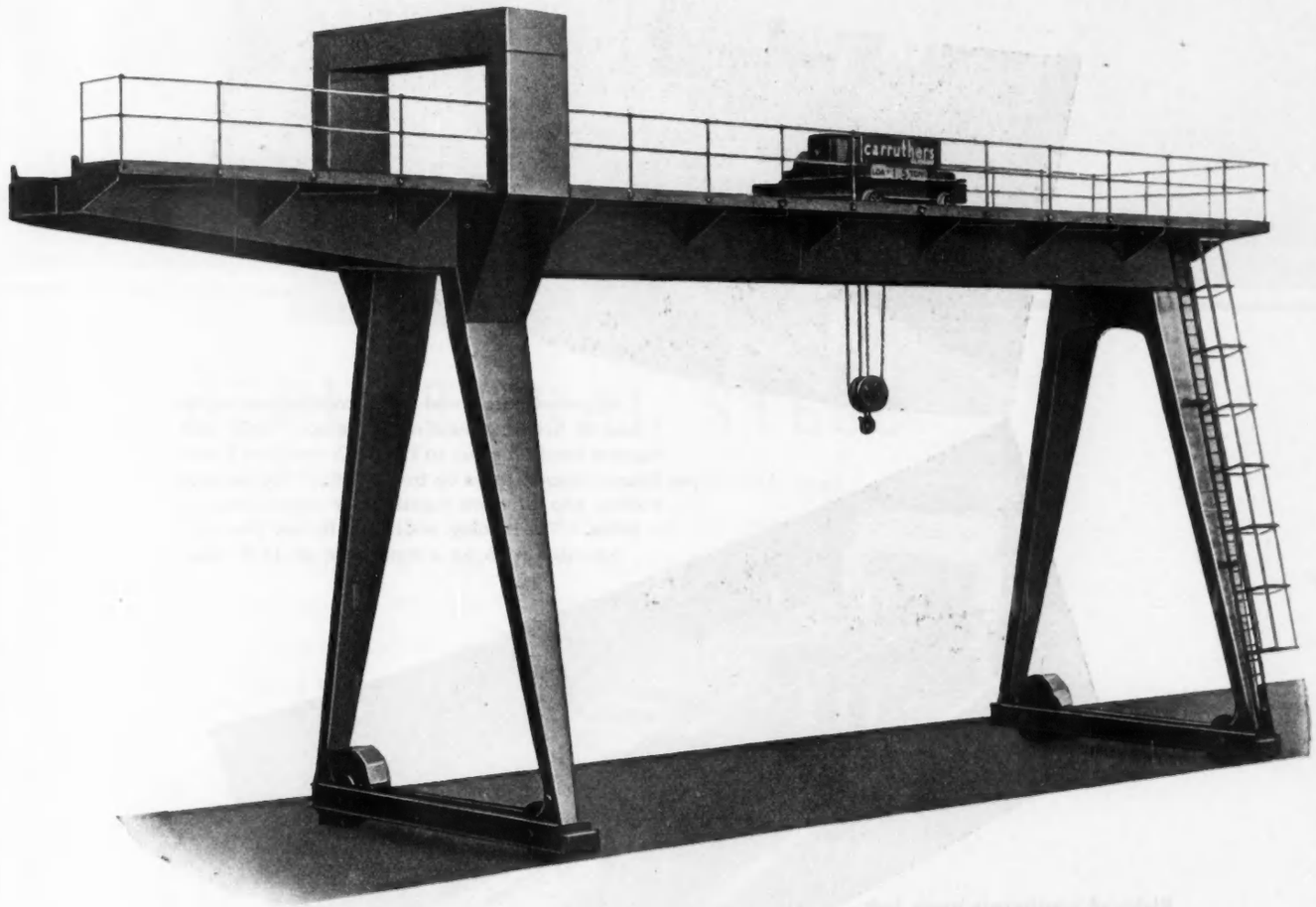

A typical medium capacity "Goliath Crane" supplied recently to an electricity authority.

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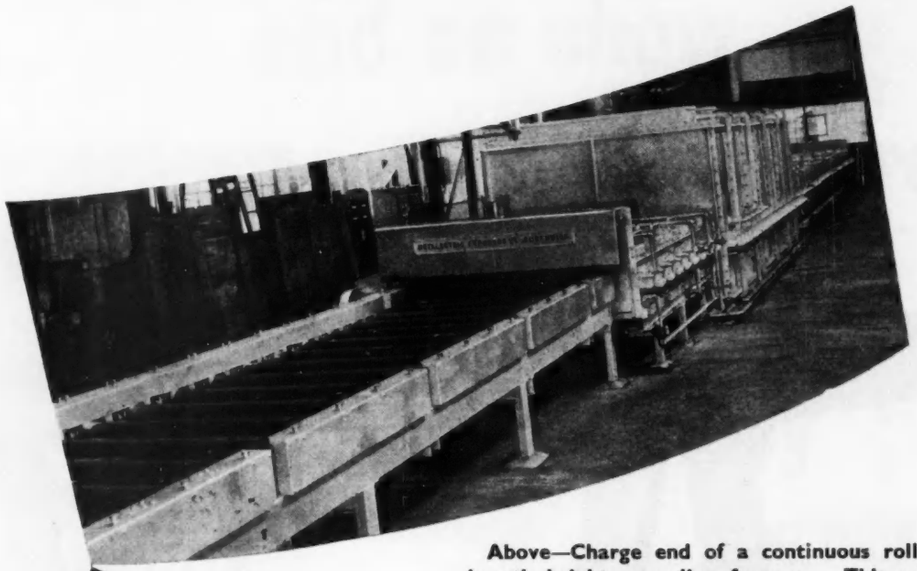
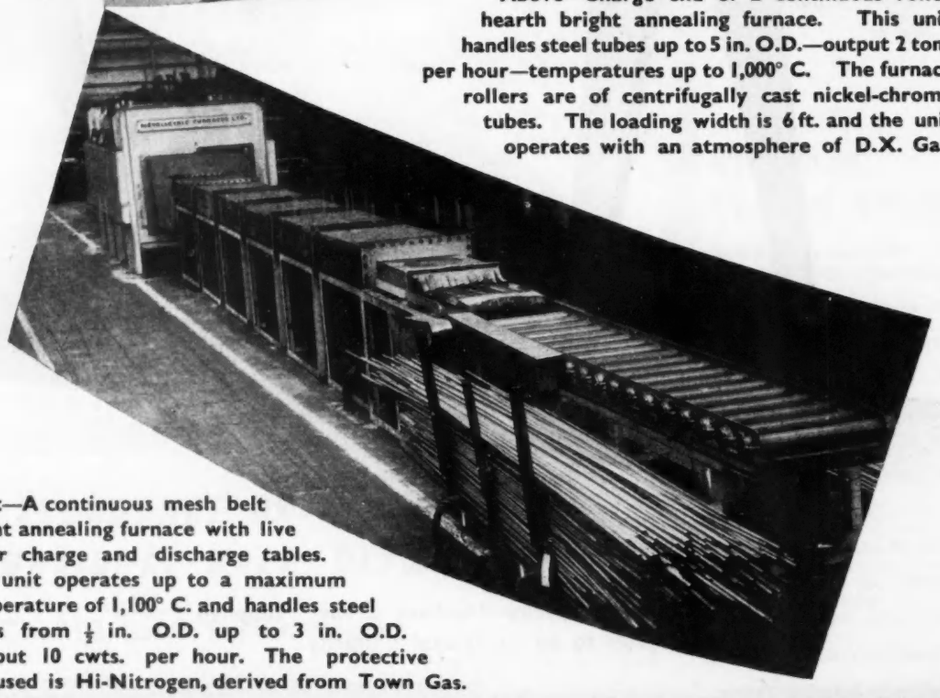


Above—Charge end of a continuous roller hearth bright annealing furnace. This unit handles steel tubes up to 5 in. O.D.—output 2 tons per hour—temperatures up to 1,000° C. The furnace rollers are of centrifugally cast nickel-chrome tubes. The loading width is 6 ft. and the unit operates with an atmosphere of D.X. Gas.



Right—A continuous mesh belt bright annealing furnace with live roller charge and discharge tables. The unit operates up to a maximum temperature of 1,100° C. and handles steel tubes from ½ in. O.D. up to 3 in. O.D. Output 10 cwts. per hour. The protective gas used is Hi-Nitrogen, derived from Town Gas.

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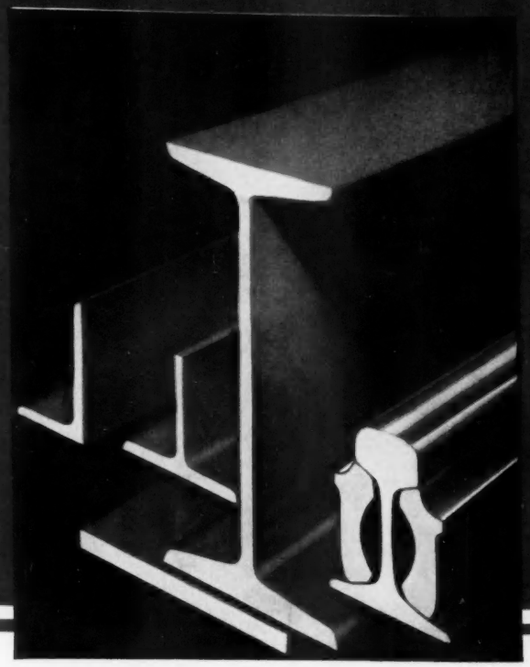

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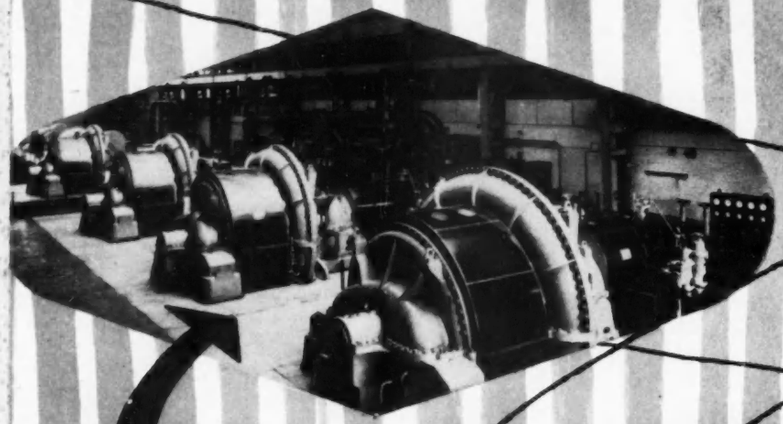

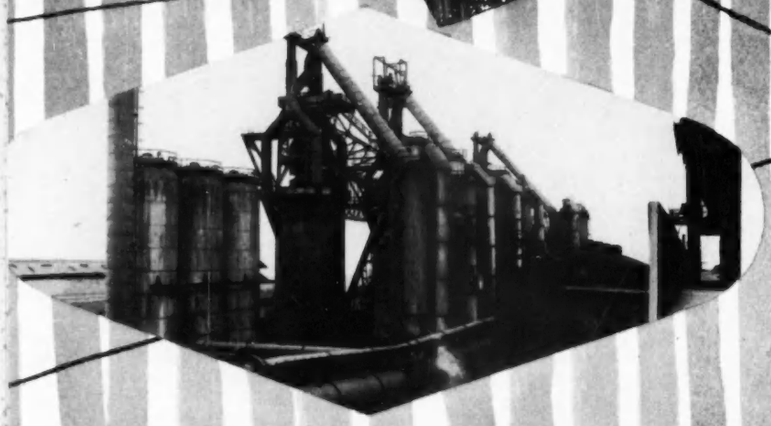

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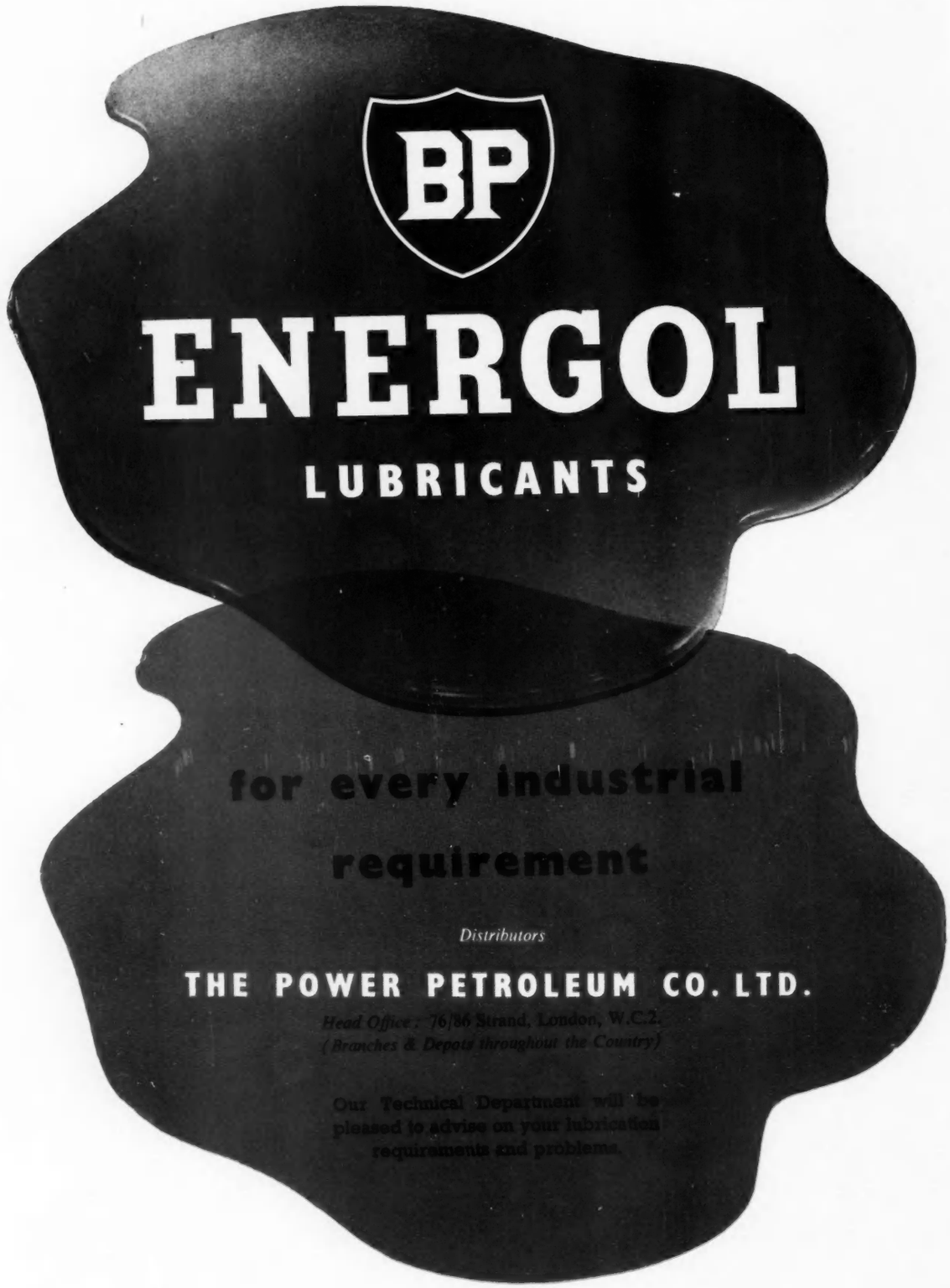
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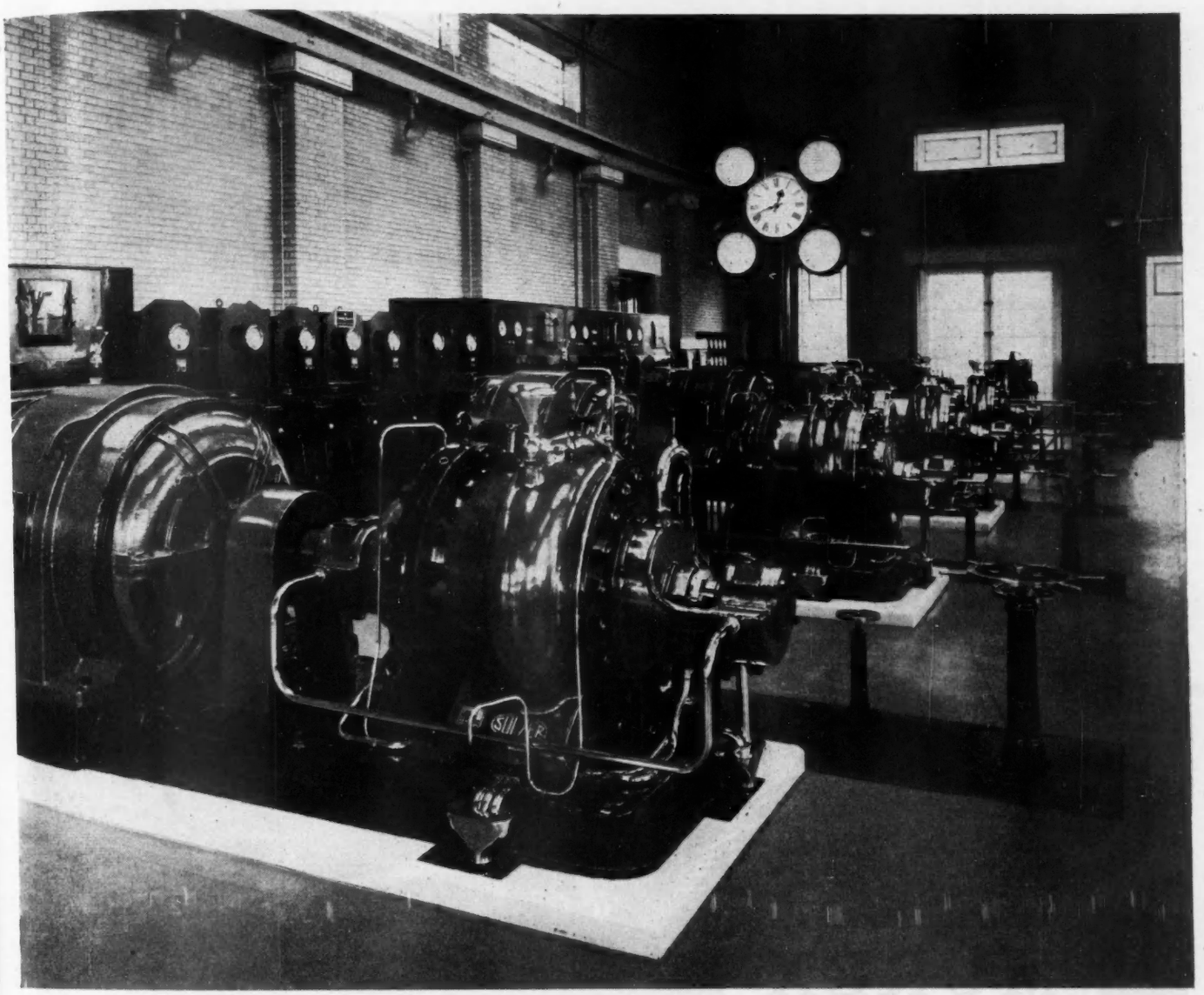

Seedy Mill Pumping Station of the South Staffordshire Waterworks Company. *R. A. Robertson, Esq., B.Sc., M.I.C.E., Engineer-in-Chief.* The illustration shows seven of the fourteen Sulzer Centrifugal Pumping Sets installed at this station.

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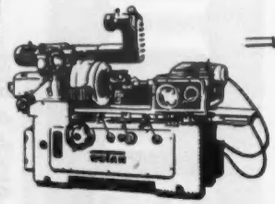
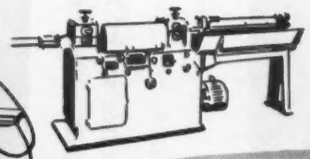

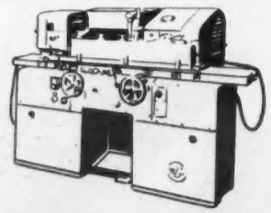
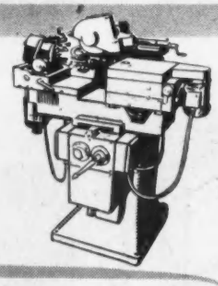
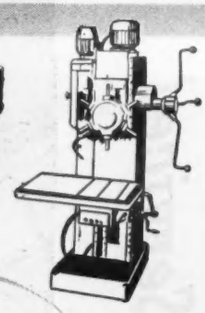
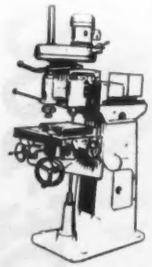

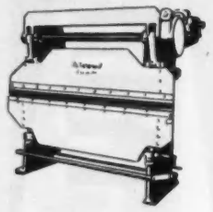
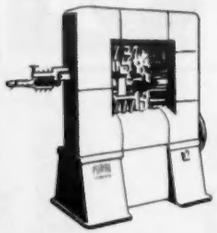
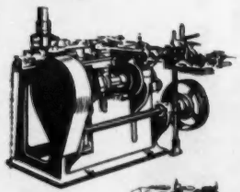
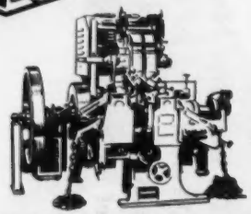

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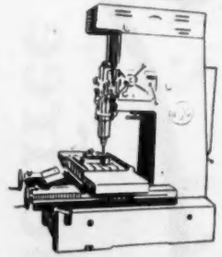
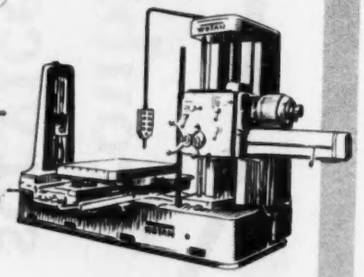

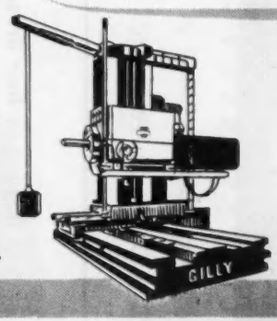

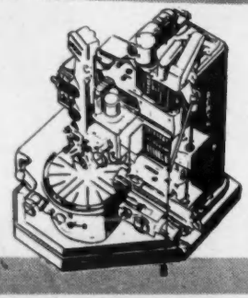
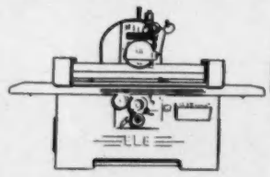
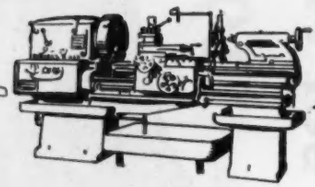

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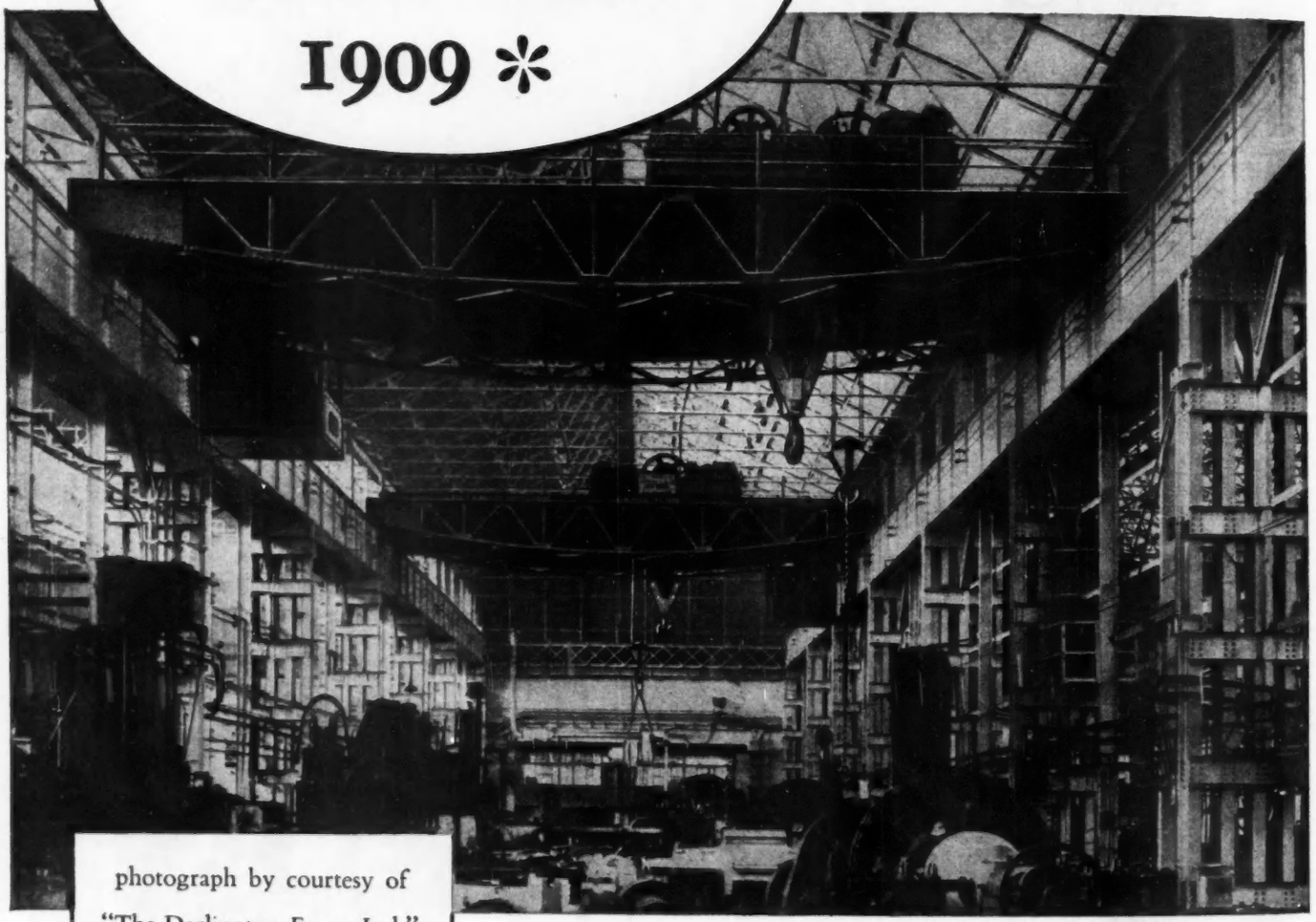

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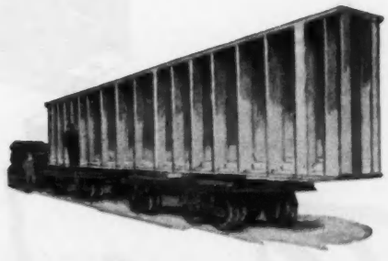

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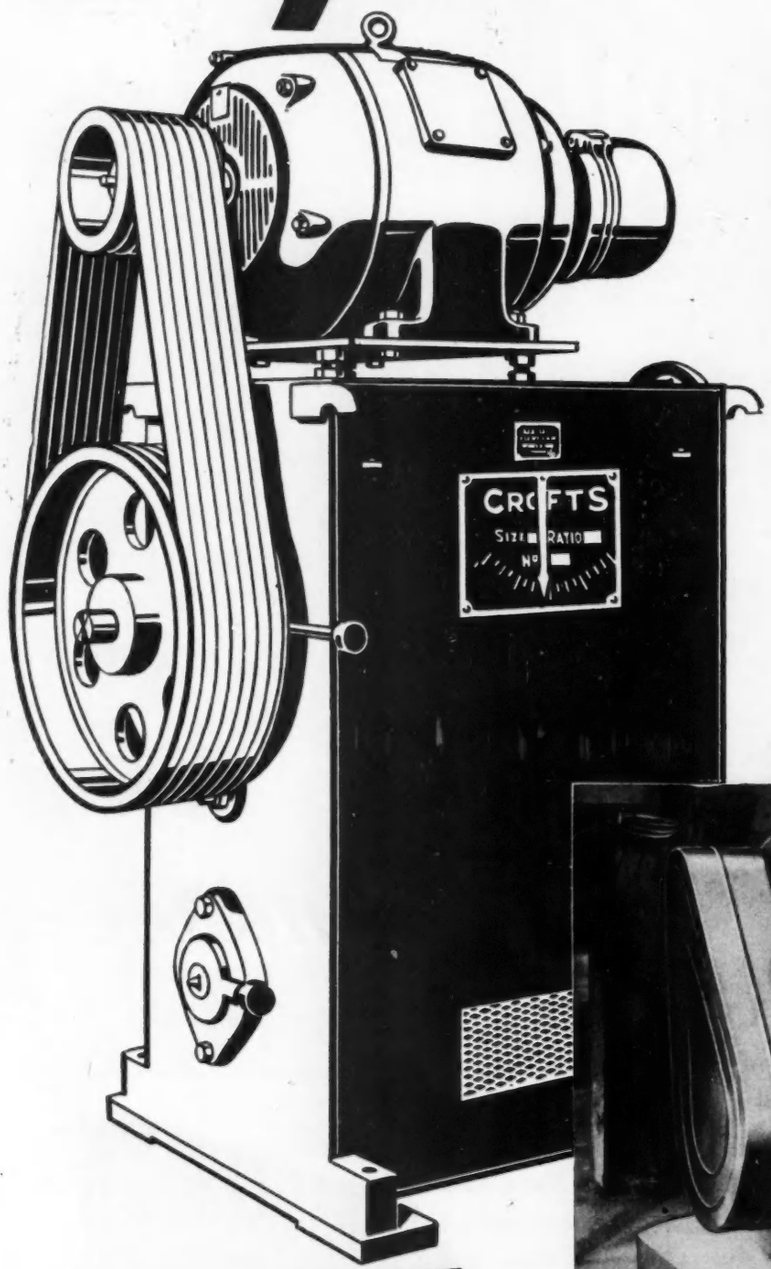

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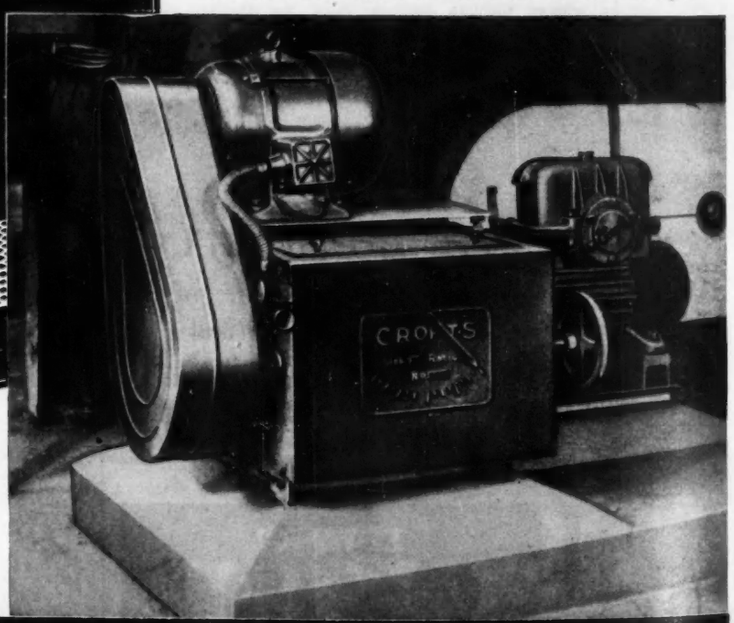

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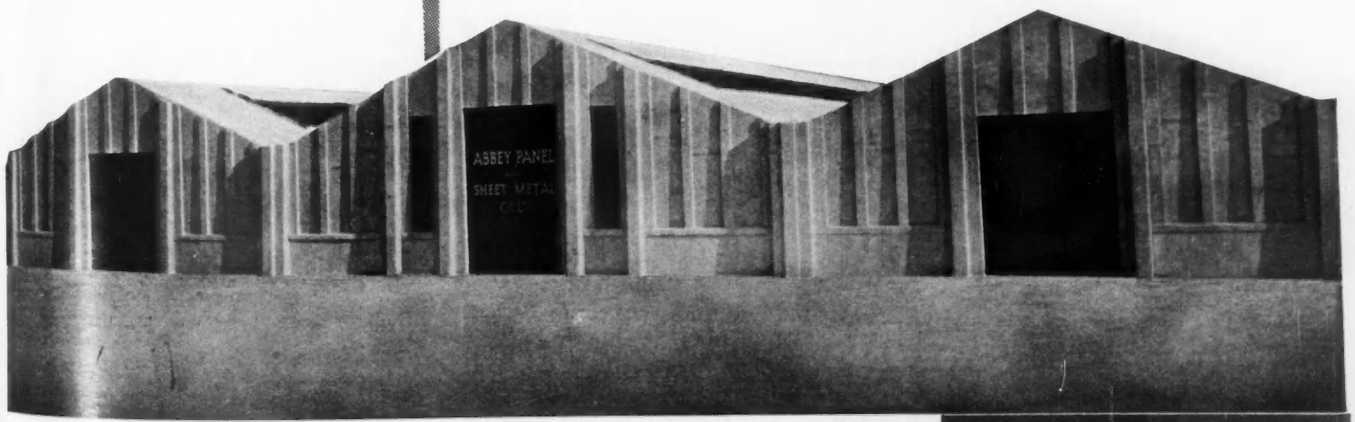

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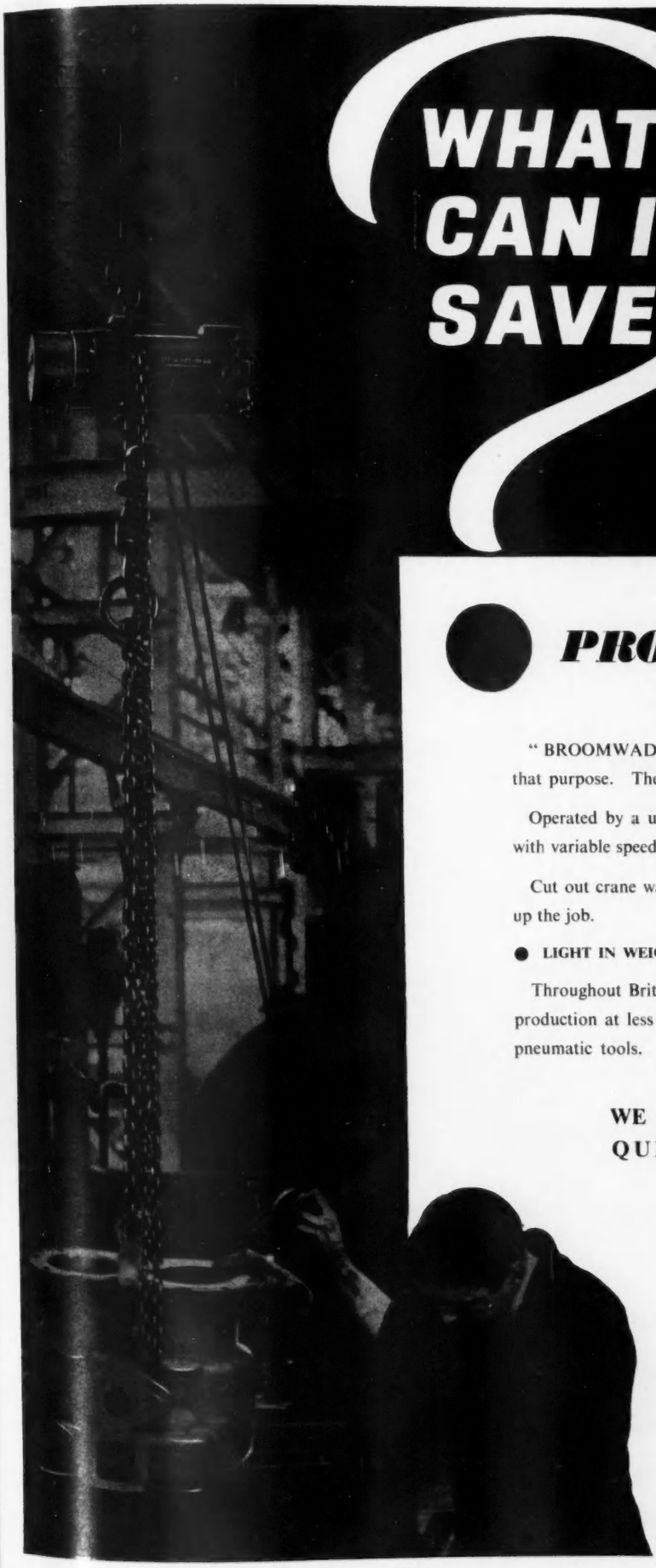

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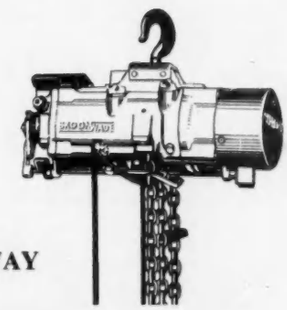

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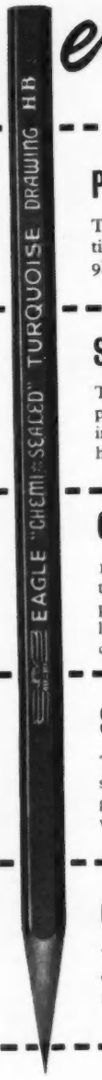

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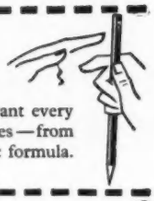

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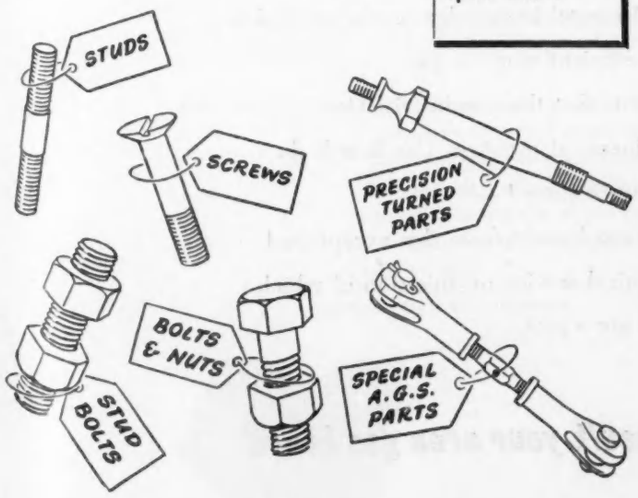

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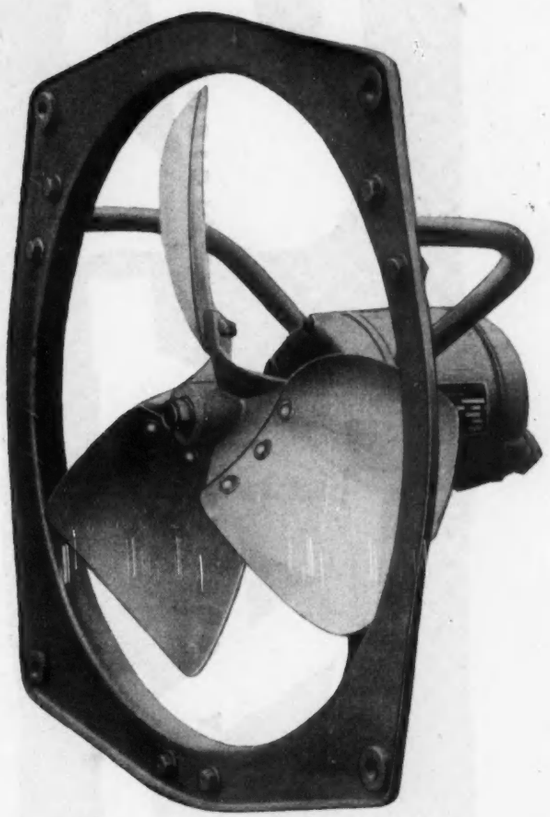

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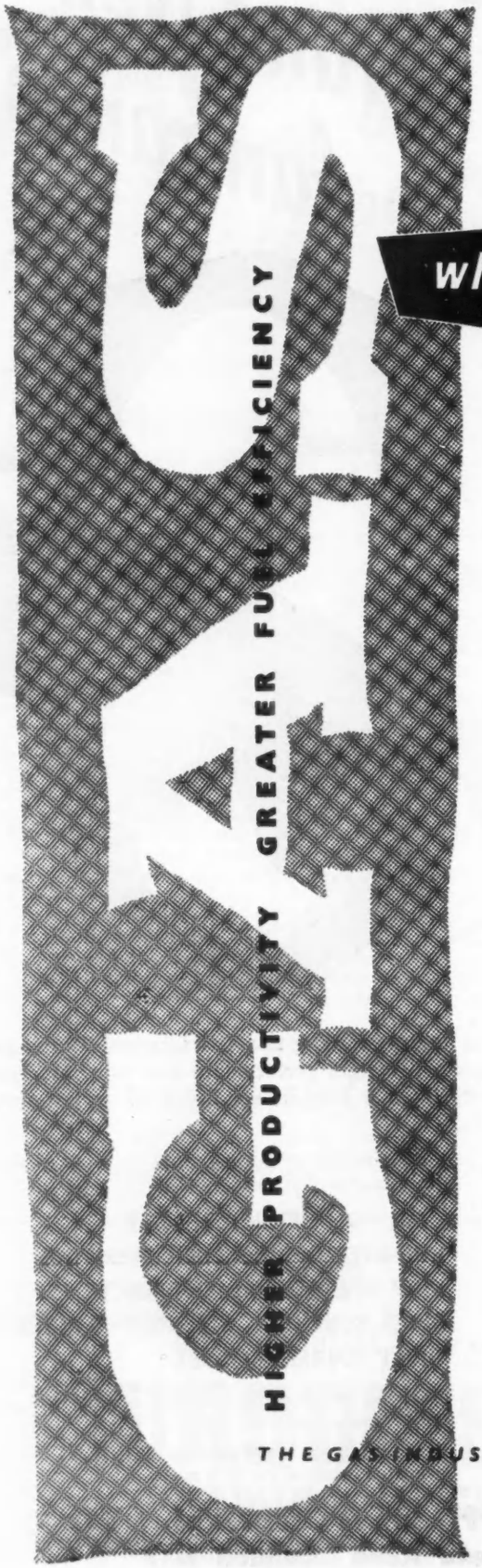

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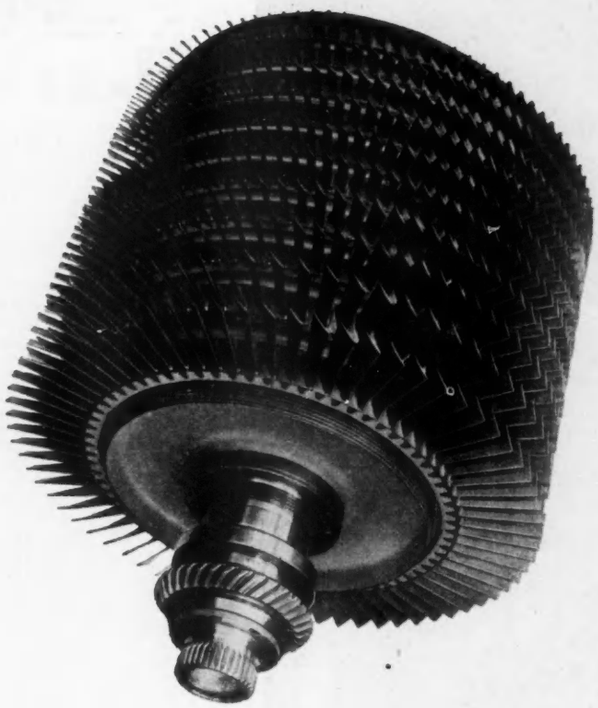

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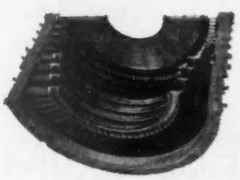

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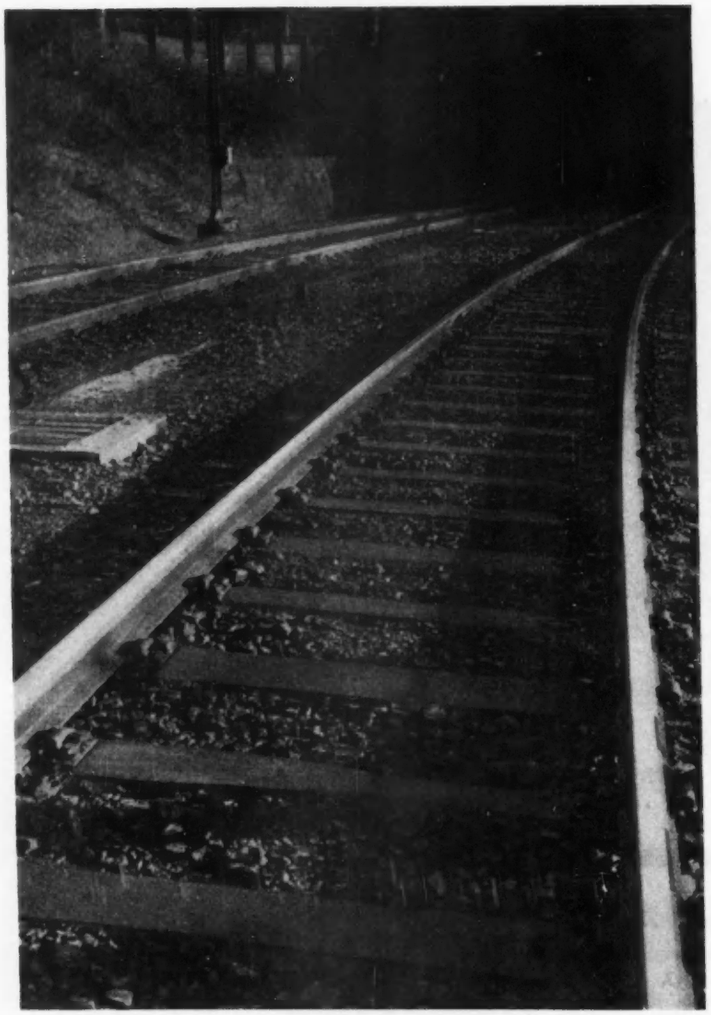

This photograph shows the Hey-Back System in use on a busy main line near Oslo : we reproduce it by kind permission of the Norwegian State Railways.

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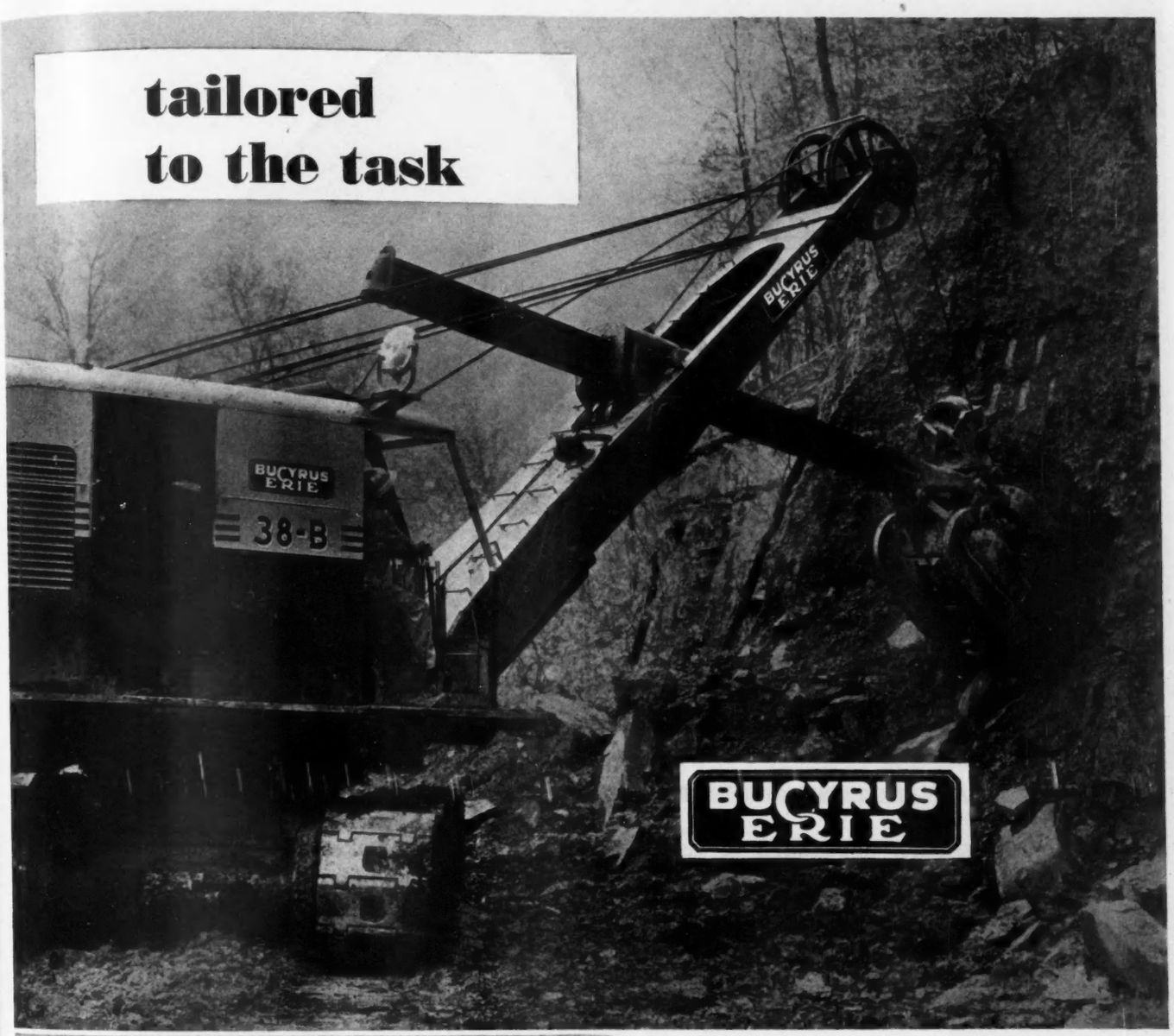

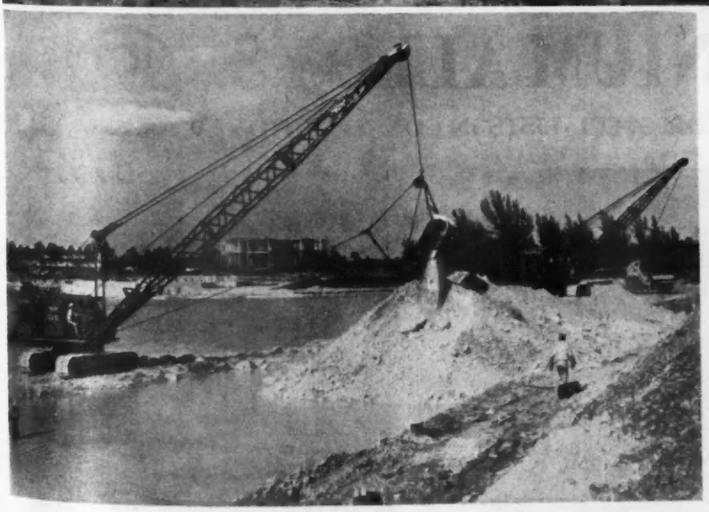

Each size of Bucyrus-Erie excavator is individually designed all the way through from caterpillar tracks to boom-point sheaves for a definite size payload. For example, in every detail of this power-packed 38-B 1½ cubic yard shovel the strength is there to meet demands. Furthermore, with main machinery, power unit and mounting all perfectly matched to front-end capacity, the danger of over-stressing gears, shafts, drums, clutches, ropes, etc., is reduced to a minimum. As shovel, dragline or dragshovel you can depend on a 38-B for hard work.

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Courtesy of Liverpool Corporation

Here is another application of versatile 'Kynal' aluminium alloys—a prototype lightweight tipping refuse vehicle with retractable wheel arch (designed and built by the City Engineer and Surveyor's Department of Liverpool Corporation) which almost makes refuse collection a pleasure. In addition to its strength and durability, aluminium offers the great advantage of being easy to keep clean.

'Kynal' aluminium alloy sheet and extrusions were used exclusively.

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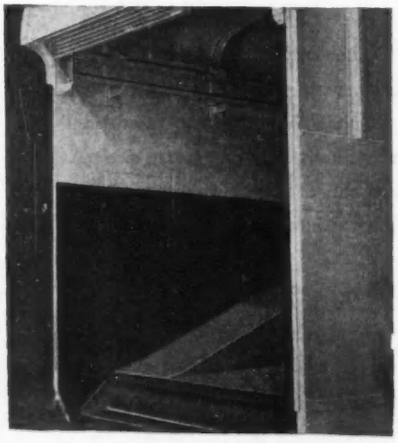

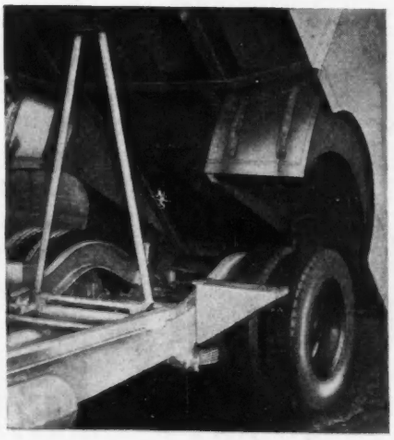

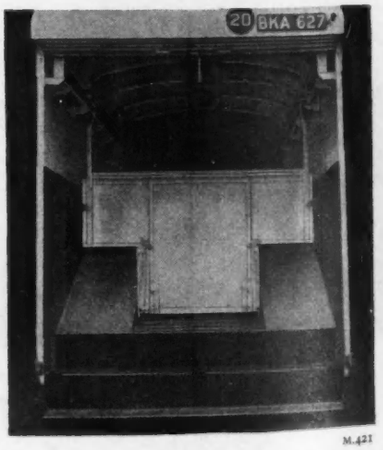

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7838

Thermocouples. For use at temperatures not exceeding 1,100 deg. C., chromel-alumel elements are used, whilst for temperatures up to 1,550 deg. C., platinum, platinum-rhodium wires are employed. On both of these types a renewable graphite sheath is used. This not only protects the elements but avoids contamination of the molten metal.

Compensating Leads connect the thermocouple to the indicator or recorder. They are asbestos covered and are conveyed from the junction box through a heavy steel conduit bent at a convenient angle.

Indicators. May be wall type or portable or, especially useful for indicating at a distance, an illuminated moving scale indicator with an effective total length of 20 inches.

7815

Recorder. When a permanent record of readings is required, the Electronic Recorder shown on the left is recommended. An automatic switch starts the chart motor when the thermocouple is immersed and stops it when withdrawn.

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How to cut hose costs

Goodyear air, oxygen and acetylene hose in use by Metallisation Ltd.

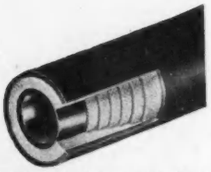
The first step in cutting hose costs is to choose the right hose for the job. That's why it always pays to use efficient and economical Goodyear hoses. They are all " job-designed " and there's one for almost every hose job.

The next step is to get the right fitting properly applied. Over 75 per cent. of all premature — and perhaps costly — hose failures are the result of trouble with fittings.

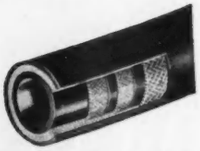
Here again you can rely on Goodyear. Our technical staff will gladly advise on the correct installation. Write to The Goodyear Tyre and Rubber Company (Great Britain) Limited, Industrial Rubber Products Department, Wolverhampton, for advice.

QUALITY

Goodyear hose is built to meet not only exact job specifications but also exact quality standards, set by years of research and experiment. These standards ensure that Goodyear hose combines maximum strength and flexibility with high resistance to wear.



WRAPPED PLY This type of Goodyear hose has layers of rubberised cotton fabric wound over a smooth-bore tube of high grade compounds and protected on the outside with a tough rubber covering. Made in 60 foot lengths.



BRAIDED CORD Braided Cord Hose embodies strong cord layers braided over a lining of high grade compounds and with a smooth, uniform bore. Made with one, two, or three braids as operating conditions demand. A heavy cover of tough rubber provides exceptional resistance to wear. Mandrel built in lengths of 60 feet.

HAND-BUILT In addition to the extensive range of wrapped ply and braided cord hoses, Goodyear supply a wide range of hand-built hoses designed to meet special operating conditions.

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ENGINEERING

An Illustrated Weekly Journal

Vol. 181 No. 4711 JUNE 22, 1956

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MACHINE TOOLS UNDER STRESS

THE level of demand for machine tools, in this country and overseas, has risen far beyond the expectations of most of the British builders. Almost without exception they have been unable to meet it, despite an increase in output last year of some 14 per cent. At the end of February, the industry's order book stood at £104 million, equivalent to at least 15 months production at the current rate. But for some machines such as large turret lathes or multi-spindle automatics, delivery dates extend up to three years. Throughout 1955 the intake of orders has exceeded deliveries by a substantial margin, which increased to 26 per cent. in the first quarter of this year. Subsequently there have been signs that the level of home orders has become stabilised at a slightly lower level, but not low enough to allow the builders to catch up very much on their backlog of orders. The credit squeeze does not appear to have affected the long-term investment programmes of the engineering industry. Short of wholesale cancellations of orders, therefore—of which there has been no sign so far—British machine-tool makers are most unlikely to be in a position to spare more for export, currently about 25 per cent. of output. Similarly, imports—which in the first quarter of this year exceeded the value of exports—are unlikely to be reduced.

There is little doubt that if British builders were able to quote quicker delivery dates, they could export more and supply at least some of the machine tools which have to be imported. Yet there has been very little expansion during the past five years. Employment—now some 43,000—rose by 12 per cent. between 1950 and 1955, but by only 2½ per cent. since 1952. Output did not rise significantly during this period until 1955, when it totalled just over £75 million compared with £65½ million the previous year. This slow expansion, in sharp contrast with the great growth in demand for machine tools, is attributable to two main factors: a deeply-rooted lack of confidence in a continued high level of demand and, more recently, an inability to obtain the labour and some of the materials they require. The industry is composed mainly of small firms (only 9 employed over 1,000 people in 1948) with limited capital resources, who have tended to consider the high level of demand as a series of booms which would not last. Their extreme caution has its roots firmly embedded in the series of slumps they experienced between the wars. During the war output was expanded mainly through the use of sub-contractors; in the past three years such capacity has been very difficult to obtain. Likewise during this period the industry has been unable to attract workers, draughtsmen and designers in competition with growth industries such as motor vehicles, electrical engineering, aircraft and atomic energy. Traditionally the makers of machines get rewarded less well than most of those who use them. This is one instance where tradition should be swept right out of court.

The belief that a high level of demand has come to stay is now gaining ground in the industry, and there is a growing determination to expand. More labour is becoming available as the credit squeeze takes effect, but recruiting the designers and draughtsmen, without whom the industry cannot play its full part in the change in production methods now taking place, is not becoming any easier. There is an urgent need to increase the rate at which apprentices are recruited into the industry, and to pay wages which will make it worth their while to stay in it. For too long the industry has been a training ground for others willing to pay more and to give better opportunities of advancement. There have of course been exceptions, and some companies have achieved very rapid expansion during the past three to four years. As a whole, however, the industry can be said to have failed to make the best of its opportunities since the last International Machine Tool Exhibition was held in 1952.

The series of articles on the machine-tool industry, based largely on the exhibits at Olympia, and beginning on page 537, will show that very substantial changes in machine-tool design have taken place in the past four years. Considerable advances have been made in the development of high output, multi-operation machines with automatic in-line transfer mechanisms. High cutting speeds have become the rule as has the fitting of auxiliary screw cutting, milling, planing and guiding motions on heavy standard machines. Electrical or electronic operation for the control of materials, cutting speed, feed, and so on, are becoming widely adopted. Higher machine output, greater accuracy and increased versatility are the keynotes of the improvements in the design of the more conventional machine tools. The progress achieved by the British industry in the development of special machines is sometimes unfavourably criticised. In this respect the shortage of design staff and draughtsmen is very serious, since most firms are unable to devote the resources needed for the design and development of the newer types of machine tools, and for giving the fullest attention to customers who want special machine tools

designed. The shortage of skilled men and the great pressure of orders, are forcing the industry to concentrate on the manufacture of standard products. This could prove a major handicap in the future, and great efforts are required to achieve what has been called " excursions in the non-standard fields " and which include some entirely new methods of metal working—such as spark, ultra-sonic and electro-chemical machining. The horizon is bristling over with challenges, and it is hoped that evidence of their being taken up by British machine-tool builders will be visible at the Exhibition which opens today.

* * *

Plain Words

A chill wind is blowing through Whitehall. The Chancellor of the Exchequer has issued orders for discharging something like 20,000 civil servants, many within the next nine months. As a result, about £15 million a year will be saved, and some progress will be made towards the target of a cut of £100 million which was set in the Budget. The Government are right to be firm in their handling of this issue, however convincing the objections may sound, as only by such resolute action can they hope to curb the natural tendency of the Civil Service to increase in size.

There are to-day about 639,000 Civil Servants compared with 387,000 before the war. The Civil Servants themselves are not wholly to blame; nor are the Government. So accustomed have we become to the idea that the State must be responsible for every scheme, however wild, which is not the obvious function of industry or individual enterprise, that otherwise sane and reasonable people are to be heard pleading that the Government should undertake this or that task. At the recent Aslib Conference, information officers and librarians examined the efficiency of their services. They discussed the idea that the time had come to carry out operational research on information services. Such research would reveal the great value of these services, and it might express the value in terms which a managing director or an accountant would respect. Information officers and librarians are convinced that their services are indispensable to industry (and Government) but they suffer from their inability to prove the point conclusively.

A very sound proposal. But its effect was reduced when several speakers proposed that the work should be carried out by the Government or, more specifically, the Department of Scientific and Industrial Research. The work is worthwhile and beneficial to industry, and there are not lacking industrial firms who would give serious consideration to contributing towards the cost of the investigation. It is the dynamic companies and groups which regularly make extensive use of information services. They would see that the operational research was carried out effectively, and there would be no charge on the tax-payer.

Fig. 1 Larger excavating and hauling plant is enabling the Coal Board to retrieve shallow seams of coal at greater depths than hitherto. Progressive reinstatement of the land is obligatory.

LARGE EXCAVATORS EXTEND OPENCAST COAL POSSIBILITIES

INITIAL EXPERIENCE AT ACORN BANK

Notwithstanding any developments that may occur in other sources of power, it is imperative, as was noted in the recent O.E.E.C. report on European fuel supplies, that there must be a vast increase in the mining of coal if the Continent is to survive industrially. Fortunately borings show that there are coal reserves sufficient to last for centuries. Gaining this coal economically must necessarily mean the adoption of methods different from those of former days, and in this respect the recent growth in the United Kingdom in opencast coal mining is particularly significant.

Since the early days of the last war, 15 years ago, when opencast mining was first begun on a large scale in this country, the cost of gaining this high-level coal has remained impressively steady, despite increasing prices in almost every other field of activity. The reason for this is the increasing use of larger and still larger excavating and hauling plant so that more and more coal beds become a reasonable proposition for working.

The general trend is the subject of comment in Weekly Survey elsewhere in this issue and there note is made of some of the recent contracts to be awarded in South Wales, the North East and in Scotland. In the following article and in the illustrations on this and the succeeding two pages is described and illustrated the work now under way at the Acorn Bank site in Northumberland, where Costain Mining Limited, a subsidiary of Richard Costain, Limited, after 12 months of preparatory work, are about to start working 16,500 tons of coal each week for the next seven years, by the end of which time five million tons will have been sent to the country's industrial and domestic users. This is only possible because, in conjunction with the Opencast Coal Executive who own the principal plant, the Company are employing the largest machines that are available—excavators with 20 or 22 cub. yd. buckets and 40 cub. yd. haulage units. In all it will be necessary to excavate 95 million cub. yd. of overburden, a dig equal to the excavation required for the construction of the Panama Canal. The land, which covers 440 acres, is to be returned progressively to general agriculture.

SITE AND COAL DISPOSITION

The Acorn Bank site, situated about one mile south of Bedlington in Northumberland, occupies 440 acres of agricultural land, and working the site has involved the diversion of a road and of

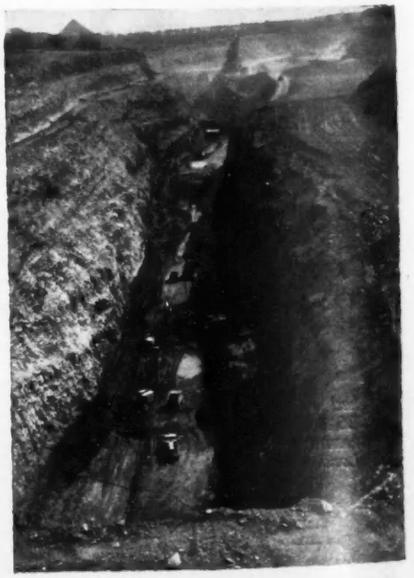

Fig. 2 The first stage at Acorn Bank has been to form the " box cut " above the deepest seams to be worked.

water and electricity mains which at present cross the site; one farm-house will also be demolished in the course of the work.

There are three coal seams on the site: the High Main, a fairly consistent seam averaging 3 ft. 3 in. thick and containing a thin band of shale about 1 in. thick; the Top Grey consisting of two leaves averaging 2 ft. 7 in. thick and with a 2½ in. band; and the Bottom Grey having four leaves, the top and bottom being of consistent unbanded coal 3 ft. 1 in. and 2 ft. 10 in. thick and the middle two each 8 in. thick with bands varying between 6 and 9 in. The spacing between the seams varies considerably over the site. Between the High Main and Top Grey the interval is 40 ft. in the west, decreasing rapidly to a minimum of 6 in. in the east. The interval between the Top Grey and the Bottom Grey varies in a north-south direction, being about 15 ft. along the northern boundary and reaching a maximum of 120 ft. in the south-east corner of the site. The maximum depth of the Bottom Grey occurs at the north-east corner of the site where the cover is 230 ft. This reduces to around 100 ft. at the western end, where the High Main outcrops below the drift.

Several faults occur within the area, mostly in the north-south direction, the amounts of throw varying considerably, but averaging between 10 and 20 ft. Drift, which covers the area, consists of boulder clay and rarely exceeds 30 ft. in thickness, except in the south-east where there is up to 50 ft. Strata over the coal seams are normal shales and sandstones, mostly fairly soft and usually broken.

WORKING ORDER

As already noted, it is a condition that restoration of the ground to agriculture shall take place progressively. This precluded the use of a permanent access ramp into the cuts, as it would have meant occupying a large area of land for the duration of the job, and other schemes had to be considered. One possibility was to construct a vehicle tunnel at right angles to the cut and in the middle of the low wall. This would be formed progressively and covered by the spoil as the cuts moved across the site. The difficulties of working the several seams by this method, and the possibility of subsidence due to the deep-mine workings beneath the site, led to the rejection of this scheme. A somewhat unusual method was finally selected—to employ a number of high-speed electric derrick cranes travelling along the high wall or berm in the cut. These cranes will hoist the coal in skips which are to be shovel-loaded in the usual way and discharged into road transport on the top of the cut.

The general method of working the site is therefore to be as follows. An initial box-cut shown in Figs. 1 and 2 has been formed along the eastern boundary. This is approximately 3,200 ft. long, 100 ft. wide on the bottom coal seam, and has a maximum depth of 230 ft. Of the 8 million cub. yd. of material to be removed from this cut a large proportion will be hauled a distance of about a mile to the previously worked-out Ewart Hill site, where it will be used to restore the area and improve drainage by the formation of a low hill. The remainder will be stacked on the Acorn Bank site for use in filling the final cut. Drainage of the cut has been catered for by driving a culvert through to a nearby river.

Fig. 3 95 million cub. yd. of overburden have to be moved. 22 cub. yd. buckets and 22 ton Euclids speed the work.

Parallel cuts, 80 ft. wide, will then be made, running in a north-south direction and progressing towards the west, the overburden being used to fill the previous cut. To assist in planning the work a large plasticine model has been built which enables the actual site contours at any time to be produced so that plant routes can be kept under constant review.

PLANT

Initially, 12 in. of top soil and 3 ft. of underlying subsoil are to be removed and either taken in the early stages to a tip or to direct restoration later on in the job. A small fleet consisting of five "Super C" Tournapulls of 12 cub. yd. struck capacity and one Euclid Twin-Power Scraper, of 18 cub. yd. struck capacity, is being used for this work. For top reduction of the drift and rock down to about 140 ft. above the bottom coal, three Ruston-Bucyrus 120RB electric shovels of 5 cub. yd. capacity are being used. Two Bucyrus-Erie 1150B draglines, on trailing cables from the local grid, one with a 180 ft. boom, the other a 215 ft. boom, will handle the remaining overburden; one of these machines is shown in Fig. 4. Final details of the method of working have yet to be settled, but it is likely that the two machines will be worked independently from opposite ends of the cut and will cross on to the low-wall side for re-handling and cross-dragging. Three Joy-Sullivan 58BH rotary air-blast drills are also in use for overburden preparation.

During the initial excavation to form the box-cut, both the draglines and the three shovels have been used to load a fleet of sixty 22 ton and 15 ton Euclid rear-dump trucks. Direct loading of a 22 ton Euclid by one of the 1150B's is assisted by the use of a skid-mounted hopper which offers some protection to the vehicle. By using a 22 cub. yd. Hendrix bucket on the other excavator, 22 ton Euclids are being loaded direct, without the use of a hopper, as is shown in Fig. 3.

Payloads average 11½ cub. yd. solid for the larger Euclids and cycles per hour are between 4 and 5 on a 10,000 ft. round haul. Great importance is attached to the quality of the site roads, which are formed of 3 ft. of sandstone rock and kept well graded. Traffic "keeps right" during the day shift and "keeps left" at night, in order to spread the wear. The traffic passes over a public road by means of a temporary double-track bridge 100 ft. long.

The coal will be dug by 1½ cub. yd. electric shovels which will load direct into the 10 ton derrick skips. The derricks, which are also electrically operated, will have 152 ft. jibs and will be rail-mounted to facilitate movement along the top of the cut. They will load direct into the transport vehicles which will consist of 40 ton bottom-dumping semi-trailers, illustrated in Fig. 5.

COAL HAULING

For hauling the coal to the screens eight bottom-dump semi-trailers are to be used with four tractors; the capacity of each trailer is 60 cub. yd., which permits a load of 40 tons. Designed by the Eagle Engineering Company, Limited, Warwick, the trailers are British made and believed to be the largest yet made in this country. The first was built and delivered in 19 weeks.

The bottom-dump doors are opened by gravity, or are held in the closed position by a series of cams, the locking gear for the cams being operated by a hand lever. The doors are closed by a cable-winch which is also hand operated. The bodywork is mainly constructed from ¼ in. and $\frac{5}{16}$ in. plates reinforced by channel and angle sections. The rear axle unit is a single unsprung axle fitted with four standard 18 in. by 25in. tyres, which are 5 ft. 2 in. in overall diameter and capable of carrying a load of 30 tons. Each tyre cost about £300. They

Fig. 4 Two Bucyrus-Erie 1150B draglines with 22 or 20 cub. yd. buckets are being used to strip the overburden and will be used for backfilling.

Fig. 5 Eight 40 ton trailers will haul the coal to the screening plant a mile away. The tractors will give the unit a road speed of 30 m.p.h.

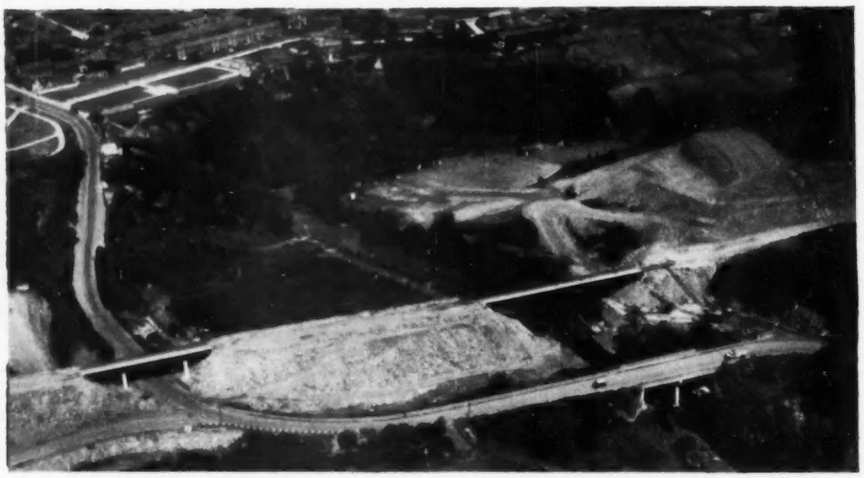

Fig. 6 High-speed working by 40 ton trailers is only possible on private roads. A motorway, involving the construction of three Bailey bridges, has been built on the Acorn Bank opencast coal site.

are interchangeable with those on the tractor unit.

Two jack legs, one of which can be seen in Fig. 5 at the leading corner of the body, and a quick-acting coupler permit the trailer to be released from the tractor during loading operations. The power for the jacks is obtained from a hydraulic pump on the tractor. The tractor itself is fitted with a 270 h.p. Rolls-Royce Diesel engine which will give the unit a road speed of 30 or 35 m.p.h.; brakes are fitted to all wheels. The approximate gross weight of the complete vehicle is 66 tons and its overall dimensions are: length, 50 ft.; width, 11 ft. 3 in.; and height 12 ft.

It has so far been found necessary to blast all material below the drift. There are restrictions on blasting due to the proximity of buildings and public services, and these have in some cases prevented the most economical loading of the holes. " Edeco " tricone bits, 6 in. in diameter, are in general use for drilling and have had a useful life of over 2,000 ft. in the shales. The drilling pattern varies, but is averaging 18 ft. by 18 ft. in the box-cut area, the explosives used being " opencast gelignite " and " 999 ", an ammonium-nitrate type of explosive, both manufactured by Imperial Chemical Industries Limited, and used in the ratio of about 20 per cent. gelignite and 80 per cent " 999." The " 999 " explosive has been used both in polythene bags and in tins, the latter in the case of wet holes which form a large proportion of the total. Blasting ratios in the box-cut are heavier than normal, due to the restricted movement of the rock, and average 4 cub. yd. per pound of explosive. This yield should be considerably increased when open-wall blasting commences.

NEW COAL HAUL ROAD

The *in situ* ash contents of the different seams vary from a minimum of 3·5 per cent. in the High Main to about 25 per cent. in parts of the Bottom Grey, but the aim is to produce a uniform product having an ash content not exceeding 10 per cent. and to achieve this crushing and blending of the different qualities of coal will be necessary. It has not been considered necessary to resort to washing the coal, but this has meant paying increased attention to digging cleanly from the seams. Cleaning before loading the coal is done mainly by hand labour, assisted by graders and bulldozers, though experiments are being made with a tractor-mounted power brush which should lead to a saving in labour.

The screening plant is situated about two miles from the site, and is approached by road, the coal being transported by 10 ton rear-dump lorries along the public highway to the screens and discharged into one of three 12 ton hoppers feeding on to three 36 in. main coal belts, which lead to the screens themselves. The capacity of each belt is about 150 tons per hour.

At the time the contract was let, about 12 months ago, the intention was to use normal highway transport to carry the coal to the screens, but several factors have since led to a change of plan. First among these is the statutory regulation which would have meant limiting the payload to around 14 tons if a normal three-axle vehicle was used. The need for good off-the-highway performance was also realised and it was impossible to reconcile this with the public highway limitations. Added to this, the proposed route was by no means ideal, as it involved several sharp bends and a steep gradient. The company therefore decided to construct a private haul road, 1½ miles long with a 30 ft. carriageway, between the site and the screening plant at Bebside.

The road required the construction of three fly-over bridges, two of which can be seen in Fig. 6. Bailey bridging—triple/single extra widened—was chosen as being the most rapid form of construction to meet the need. Two of these, each 120 ft. long, cross main roads and are supported on 18 ft. high reinforced concrete columns of 4 ft. diameter. The third, which crosses the River Blyth and is 190 ft. long, is supported on timber trestles. The foundations are of mass concrete, and decking to the bridges is of sawn greenheart planking. The assembly was carried out on the embankments and the spans lifted into position by a Lorraine crane with a 70 ft. jib. Guard frames have been fitted to the bridges as a precaution against falling coal.

More than 50,000 cub. yd. of drift and clay had to be excavated in cutting a way for the road, and for building the road itself about 100,000 cub. yd. of rock fill—yellow sandstone and hard white post stone—were taken from the Acorn Bank site and laid, graded and rolled. The fill varies in depth between 3 ft. and 60 ft., and was transported by a fleet of 22 ton Euclids.

ELECTRICAL LAYOUT

All power for operating electrically driven plant on the site is taken from the public supply system, or National Grid, at 20 kV and 50 cycles per second. Two 3,000 kVA transformers reduce the voltage to 3·3 kV before it is transmitted to the site by overhead line. A portion of the supply passes through a pair of frequency boosters which convert it to 4·16 kV, 60 cycles per second, as required by the two draglines, which are of American origin. All other plant operates at the supply frequency of 50 cycles per second.

Overhead lines carry the current from the sub-station to the two ends of the cut at either 4·16 kV or 3·3 kV, whence it is fed to the machines through trailing cables. Field switch gear is skid-mounted and of the all-weather type.

Additional field transformers have also been installed to reduce the voltage still further for use by the coal shovels, hoisting derricks and for site lighting, so that full 24 hour working can be undertaken.

Special accommodation has been built on the site to house the engineering and administrative staff and to provide accommodation for the National Coal Board's resident engineer and his staff. Canteens are available for all engaged on the site and one of the larger canteens can be turned into a cinema for showing films concerned with safety precautions, plant operations and other relevant topics. The plant depot, consisting of repair shops and stores, is located near to the administration block; five large Romney huts, of corrugated sheeting on tubular steel ribs, house the repair shops, each being devoted to a different class of work such as machine shop, tractor repairs and so on. The stores building, which extends along the back of these shops, is provided with separate service counters to supply each section with the necessary spares, which are stored in racks.

Letters to the Editor

PASSENGER MOVEMENT

SIR, As the British licensees of the " Speedwalk " conveyor we are naturally, greatly interested in the letter to the Editor, under the above title, in the June 8 issue of ENGINEERING.

It is true that there is little " new under the sun," but often the main reason for the failure of an original idea is the result of a secondary problem rather than its inherent ability to deal with the purpose in view.

Like the " Neverstop " railway installed at the Wembley exhibition in 1924, the " Rapid Transit Passenger Platform " appears to incorporate an undesirable feature which requires the passenger to step from a stationary platform into a carriage moving at right angles to his normal direction of travel. This relative movement, limited even to 2 m.p.h., would nevertheless be sufficient to deter the timid, the immature and the aged from using the device, creating sufficient problems to render the installation a doubtful commercial risk.

The model described in the issue of May 18, actually illustrates the " Carveyor " system in which the carriages circulate in much the same way as the " Rapid Transit Passenger Platform," but which in addition is provided with moving platforms at all points of ingress and egress, the speeds of which are synchronised with the speeds of the cars at those points. Entrance to these platforms, which are in themselves " Speedwalk " conveyors, is in the direction of travel only, which allows even the crippled, using crutches, to step on without difficulty. Once on the " Speedwalk," there is no relative movement between the passenger and the car he intends to board, so that in effect he steps into a stationary carriage.

As the same conditions apply in reverse at the unloading stations, the only points of relative motion are those between the end of the " Speedwalk " platform and *terra firma*, and *vice versa*—a step which is even simpler than the use of a normal escalator.

It is this essential difference between the " Carveyor " and the earlier designs which renders it more acceptable to the general public.

Yours faithfully,

for RICHARD SUTCLIFFE LIMITED,
H. STREETS,
Projects director.

Universal Works,
Horbury,
Wakefield.
June 12, 1956.

PRODUCTION DEPARTMENTS NEED MORE GRADUATE ENGINEERS

AMERICAN AND BRITISH TRAINING COURSES

The idea that the "college boy" is of no use to the practical manufacturer is one that still lingers in the backwaters of our industrial countryside. It is even to be found in some branches of engineering that should be the most advanced. Conversely, the idea of a career on the production side of an engineering firm, at least before he has reached the higher levels of management, has not in the past appealed very much to the university graduate, who has preferred those aspects of engineering work which approximated more nearly to his university studies: the fields of research and design.

Nevertheless the tradition of an engineering pupilage and, more recently, a graduate apprenticeship spent almost entirely in the works, is an old one which is intended to teach the future designer, sales engineer or manager something of the skills employed by the craftsman on the shop floor. If the usual two years are spent in a variety of departments it is unlikely to make a craftsman of the apprentice and its value has always consisted more of the fact that it taught him what the atmosphere of the shop floor was like and what was the attitude of those who worked on or near it.

Little attention has been given to the method of training the graduate who has come straight from school and university to the tasks of practical engineering, and, in too many cases, the complaint is heard that he is pushed around from foreman to foreman and is given too little to do and too much time to do it in. The manufacturing processes in engineering were the last to which the scientific method was applied and so have continued longest on the basis of tradition handed down by example; but to-day, with the development of new scientifically produced materials and of new and more complicated manufacturing techniques and with the growth in complexity in industrial organisation, there has come an awareness of the need for more formal methods of education and training for those who have charge of them.

INDUSTRIAL ENGINEERING

Two developments, at first separate, have been taking place in the education field to fill the gap: courses in production engineering and courses in industrial management. Neither has gone very far in this country, but in the United States the universities have developed them on a large scale. Courses in business management itself have not proved as satisfactory as their American advocates at one time suggested they would; but there is an increasing interest in courses which combine production engineering and management subjects, to which the name is frequently given of industrial engineering. These courses are of great variety and many are described in the reports of two members of a small mission from this country which visited the United States to study them in 1954.[1, 2]

Comparisons are always difficult because of the differing educational systems, but these reports show that American industry was at that time absorbing industrial engineering graduates at the rate of more than 1,500 a year. As many as 6,600 students were working for first degrees and 1,610 for higher degrees, compared with 44 Higher National Diploma and degree students and 52 post-graduate students in comparable courses in the United Kingdom; but, in addition, there were in the United Kingdom nearly a thousand students taking the H.N.C. in Production Engineering through a much narrower course. In the United States the number of industrial engineers in the population had increased in the ten years to 1950 from 9,800 to 46,000, compared with an increase in all the other trades in branches from 268,100 to 373,600.

There is a growing insistence in the U.S.A. that courses in industrial engineering should be based on a good fundamental education in mathematics, physics and mechanical science and in most four-year courses the first two years are largely confined to mechanical engineering. The basis of the industrial engineering course is the link between technology and administration. The student is introduced early not only to the special subjects of production such as tool design and production methods, but also to the "tool subjects" of management: time and motion study, quality control, job evaluation and so forth. In the five-year course at Cornell University (equivalent to four years at a British university) emphasis is put on the need for sound background in materials, design, statistical procedures, materials processing, gauging and inspection, methods engineering, cost accounting and production engineering including product analysis, plant layout, engineering economy and production control.

MATHEMATICS IS FUNDAMENTAL

Attention is concentrated in the later years on the economic aspects of the industrial process and the mathematics is orientated to the problems of operational research, including linear programming, work study and statistical quality control. In an interesting table of 41 subjects arranged in the order in which they were considered of importance by teachers and by companies, both lists contained motion and time study, mathematics (placed first by the companies) and operational analysis among the first five.

In spite of the support which American industry is giving to courses of this type, they receive no special preference, but they are accepted as an area of study of individual, recognisable characteristics, providing a suitable background for primary employment in functions concerned with manufacturing. In this they will merely play their part as one of the forms of engineering education which, in American industry, lead to top management positions. As evidence that American industrialists are not certain that the final answer has been found, it is interesting to observe that they showed considerable interest in the British system of part-time and sandwich courses.

The British introduction of the Diploma in Technology, to be awarded largely to sandwich-course students in colleges of advanced technology, provides the opportunity for the development of courses of industrial engineering in this country. If there is full co-operation between industry and the colleges, they would have the added advantage over the American system of an integrated arrangement of basic education and practical training; but if such an arrangement is to be successful the practical training must take account of the special abilities which the student at a university or college develops, to which attention has recently been drawn in a most stimulating paper read to the Institution of Mechanical Engineers.[3]

MANUAL SKILL NOT NEEDED

In the experiment described in this paper, the graduates were trained not by spending a few weeks in each department trying to learn by example something of its skills and methods, but by lectures and carefully devised exercises involving the preparation of reports. The exercises were designed to teach the fundamentals of the cutting process, the organisation of the shop and the roles played by different people on the shop floor, the operation planning of simple components and the procedures involved in the control of production from the issue of the design, through the production of detailed drawings, parts lists, tool drawings and shop orders to the completion of the assembly. No attempt was made to inculcate manual skills on which the graduate's academic knowledge has no bearing, but to give him some understanding of the technology and organisation of production of which all professional engineers should have at least a working knowledge. The graduate who then decides that he wants to specialise in this field can go farther.

The integration of such a system of training with the college course, although difficult especially for the smaller firms, would enormously increase the value of the Dip. Tech. student. It would also allow an economy in time which would be of great help if the college courses are to be both sufficiently broad and adequately specialised. For instance, the authors of the paper suggest that, where the methods of operational research are not taught at the university, exercises which use them are a useful method not only of establishing fact for the student, but also of enlarging his knowledge of the fact-finding methods available. There would seem to be here a fruitful field for collaboration between the teaching of statistics at the college and the training in operational research in the factory.

This is a period not only of expansion, but also it is to be hoped of experimentation, in the training of engineers. We have the opportunity to build up a system which utilises not only the best experience of our own past and the methods of other countries, but also the results of experiments scientifically carried out by forward looking teachers and practising engineers.

REFERENCES

[1] "American Teaching and Practice of Industrial Engineering and Management." J. Cherry. The College of Aeronautics, Cranfield, note No. 39.

[2] "American Methods of Training in Industrial Engineering and Management in Universities and Industrial Plants." T. B. Worth, *Institution of Production Engineers Journal*, May, 1956.

[3] "An Approach to the Techniques of Graduate Training," by D. L. Marples, J. F. A. Radford and J. L. Reddaway, *Proceedings of the Institution of Mechanical Engineers*. To be published.

150 YEARS OF CHAIN MAKING

New Laboratory for Brown, Lenox & Co.

The firm of Brown, Lenox and Company, Limited, of Millwall, London, and Pontypridd, Glamoran, was founded in 1806 by Lieutenant (later Captain) Samuel Brown, R.N., who was the first to use wrought iron for ships' cables and rigging. For this invention he was knighted by King William IV in 1835 and received the further honour of Knight Bachelor from Queen Victoria in 1838. It was he also who introduced the use of stud-link cable. He was financed by Mr. Samuel Lenox, and thus the firm became Brown, Lenox and Company. The manufacture of cables according to his method began in premises in Ratcliffe, London, and later in Southwark, but in 1812 works were laid out at Millwall and four years later an additional plant was provided at Pontypridd. In addition to marine cables, the firm supplied suspension chains for a number of important bridges, including the Hammersmith Bridge and the Menai Straits Bridge, and for the old chain pier at Brighton. The manufacture of permanent moorings followed, and the firm thus became the first makers of iron buoys; and, as a natural development, they soon began to undertake the forging of anchors. The outfit of cables and anchors for the Great Eastern was one of their important contracts. They also equipped the first Mauretania, for the Cunard Line, with cables 3¼ in. in diameter—at that time (1906) the largest ever made—and later the Aquitania, with 3⅞ in. cables.

In 1922 a steel foundry was built, and in 1928

a patent was taken out for cast-steel cables, which are now made in large quantities. Only one other firm in the world (in the United States) has been approved by Lloyd's Register for the manufacture of cast-steel chain for ships' use. During the past half-century many other products have been added to the range of manufactures, including railway-wagons springs and volute springs, and pit trams. Under the present division of their work, buoys, pressed-steel tanks and a variety of fabricated plate work are produced at Millwall, all the other work being carried out at Pontypridd, where, on June 12, the attainment of 150 years of continuous production was marked by the opening of a new testing laboratory.

Sir George Briggs, who performed the opening ceremony on the invitation of the chairman, Colonel P. H. Jones, M.C., T.D., D.L., reviewed briefly the history of the company and stressed the efforts they were making to maintain the quality and competitive cost of their products in the face of increasing foreign competition. He developed this theme more fully in proposing the toast of " The Company " at the subsequent luncheon, which was attended by the Most Rev. the Archbishop of Wales, the chairman (Councillor D. G. Ball, J.P.) of the Pontypridd Urban District Council, representatives of the Admiralty and other Government Departments, and many of the leading industrialists of South Wales, especially those connected with the production and use of steel. Colonel Jones, in replying to the toast, observed that the works had been established in Pontypridd before the town bore that name; it was previously known as Newbridge, the name which is still that of the works. During that long sojourn they had gathered round them a corps of fine craftsmen, but they had always moved with the times and had succeeded in linking the traditions of the old crafts with the needs of the present.

The toast of " The Guests " was proposed by Mr. Hugh Lenox—whose grandson is an apprentice in the works at the present time—and was acknowledged by the Archbishop of Wales and by Mr. Julian Pode, managing director of the Steel Company of Wales.

In the marquee in which the luncheon was served, a number of exhibits were arranged; some historical, such as early records of tests (Samuel Brown constructed the first chain-proving machine in the world, which, modernised by an electric drive, is still in use) and others, likely to become historical, which included the roller fender for berthing ships alongside quays, and a diagram illustrating the mechanised chain-making plant is now being installed.

The new laboratory, which the guests were able to inspect after Sir George Briggs had declared it open, comprises three main sections, namely, equipment for metallurgical investigations, a furnace laboratory, and a sand laboratory. The main metallurgical laboratory is equipped to deal with the chemical analysis, mechanical testing, metallography and gamma-radiography relating to the products of all the departments; heat treatment, pyrometry, and quality control; works inspection; and advisory services to customers and to the local industries generally. The equipment includes an Avery 30 ton self-indicating universal testing machine and a Vickers Pyramid hardness tester. The furnace laboratory will enable complete technical control to be maintained over the whole process of steelmaking, including scrap analysis and bath sample analyses. In the sand laboratory, in addition to the routine testing of sand mixes for moulds and cores, research will be undertaken for the improvement of mixes, and continual observation will be maintained over the quality of the castings and the working efficiency of the mould and core preparation plant.

In an adjacent building, the firm had arranged for the occasion a comprehensive display of their current products, amounting to nearly 120 items and ranging in size from fittings for wire rope, weighing less than 3 lb., to an automatic coil lifter in cast steel for the Steel Company of Wales, weighing 2½ tons.

Weekly Survey

Cover Picture : *Our illustration this week shows a single-piece steel forging having integral discs and intended for the low-pressure rotor of a 100 MW steam turbine. The forging, which is shown after rough machining, weighs 35 tons, has a length of 18 ft. 2 in., and a maximum diameter of 54 in.*

★ ★ ★

Machinery Stays Buoyant

Some idea can now be obtained of the effect of the credit squeeze on the production and delivery of plant and machinery in the first quarter of 1956. The general impression is that the credit squeeze has been felt mainly on the sale of consumer goods, particularly consumer durable goods such as motor cars, radio and television sets and domestic appliances. In the latest issue of the *Monthly Digest of Statistics*, figures are given of the activity in certain industries through the winter and early spring months. They confirm the general impression to a notable degree.

The production of industrial valves, machine tools, accounting machines, mechanical handling equipment as well as of excavators and pumps all showed improved production or delivery figures (depending on which are published) in the first quarter of 1956 compared with the same quarter of 1955. Two interesting categories, coal-mining machinery and portable tools of various kinds (including welding sets and compressors) have no published figures as yet for later than the fourth quarter of last year, but even these show in most cases a substantial advance on the corresponding quarter of 1954. The machinery category showing the most disappointing results since the credit squeeze was intensified has been agricultural machinery, a subject, discussed in the following note.

In contrast, the latest figures in the *Digest* for radio and television sets show the expected heavy fall, especially in radio sets, but most electrical appliances have been doing less business through the winter than at the same time a year earlier and this generally adverse trend must have made a serious impact over a wide range of activities in light engineering.

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Agricultural Machinery

Statistics issued last week by the Agricultural Engineers Association Limited, show a marked decline in production and sales of both agricultural machinery and associated tractors in the first four months of 1956 compared with the corresponding period of 1955. In the case of agricultural machinery there has been a particularly marked fall in home sales and the Association consider that since little improvement can be expected during the next few months, total home sales for 1956 are likely to be more than 20 per cent. below those for the previous year. Exports of agricultural machinery over the period January to March, declined from £3·4 million in 1955 to £3·2 million in 1956. This represents a fall of only 4 per cent., but since export prices increased over this period it is estimated that, in numbers of machines, exports probably fell by as much as 10 per cent.

Tractor exports, which are recorded by number, fell from 44,287 in the first four months of 1955 to 33,850 in the corresponding period of 1956, a decline of just under 20 per cent. The fall in exports of agricultural machinery was spread over most categories with the notable exception of combine harvester threshers (of which exports increased by about 14 per cent.) and of ploughs for animal power. Similarly, the decline in exports was spread over most of the principal markets, though both France and Denmark increased their purchases in 1956.

An interesting comparison is also given in the same figures between German and U.K. exports of tractors for 1955 and the first two months of this year. These show that in a number of markets British manufacturers have lost ground, particularly in South America, France, Belgium and Italy, though German manufacturers have not so far made much headway in Commonwealth countries. The Association expressed the view that the year 1956 is likely to provide a serious test for British tractor manufacturers in oversea markets, though there are good prospects that no further ground will be lost since the trend of German prices is said to be rising even more rapidly than is the case in this country. It is clear, however, that the British agricultural machinery industry is in no position to stand a further sharp rise in manufacturing costs.

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Aircraft Parts and Pit-Props

The year 1931 was hardly a good time to start a new business, but in that year a young draughtsman named George H. Dowty gave up his job and became a manufacturer of aircraft undercarriages. His beginnings were modest enough; his factory was a loft over a garage, his machinery a hand-operated drilling machine which cost 50 shillings, and his first order was for six internally-sprung wheels. Today, the tiny business has grown into the Dowty Group, an organisation of 15 companies with connections in many parts of the world and interests in other fields besides aircraft. At its head is the man who founded the concern 25 years ago—Mr. George H. Dowty, whose services to industry were recognised by the honour of a knighthood in the Birthday Honours List. Some of the early struggles of the Company, and its growth into the well-known concern it is today were recalled at a luncheon held at the Group headquarters, Arle Court, Cheltenham, Gloucestershire, on June 15, in celebration of the parent Company's silver jubilee, and a record of the Group's past and present operations has been prepared in brochure form.

Up to the outbreak of war the output of the firm was confined to equipment for the aircraft industry—in fact the name was originally Aircraft Components, Limited, but in 1940, the change of name to Dowty Equipment, Limited, took place. Since the war other lines have been developed alongside the original one, which has been extended considerably. Some developments have obvious connections with the original business, the subsidiary company Dowty Fuel Systems, Limited, is an example. Another, the business of Dowty Seals, Limited, has developed from the older branches of the Group.

One development, the establishment of Dowty Mining Equipment, Limited, is of particular interest, for the production of pit-props has, at first sight, very little connection with aircraft undercarriages. But the pit-prop is not an ordinary one. It is hydraulic, offering many advantages over the rigid type, and its development by the Dowty Group out of the hydraulic equipment used in undercarriages was based simply on knowing a great deal about hydraulics and on having the vision to see other possible applications. From the simple prop has developed a growing range of other Dowty hydraulic equipment for the mining industry and progress in this field continues. There is, for example, in addition to the activities already mentioned, a further subsidiary, Dowty Hydraulic Units, Limited, which makes pumps, valves, couplings, rams, and railway buffers. But the newer fields have not been neglected. The latest development within the group has been the establishment of Dowty Nucleonics, Limited, which is concerned with electronic and nuclear instrumentation, a field in which it would be rash to forecast any limit to development.

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Opencast Coal Mining

Currently opencast coal is being produced, on an average, at a man output of six times that associated with deep coal mines and at about 8*s*. a ton cheaper. Experience during the past five years has shown that, in spite of generally

rising prices, the continous introduction of larger and larger excavating and hauling plant has enabled the cost of opencast coal to be kept remarkably constant. From grabbing coal some 35 or 40 ft. below the surface, as was good practice only so recently as 1950, there are now several sites in South Wales where a 200 ft. overburden is being dug, and at Acorn Bank, in Northumberland, where serious coaling is about to begin, an overburden of 270 ft. has been cut away. Experience there and at nearby Radar, where a similar dig has been tackled, has encouraged the National Coal Board to announce that preliminary work is to begin on their most ambitious opencast project, at Westfield, Fife, some 15 miles north of the Firth of Forth, and there it is expected to raise coal from 700 ft. below the surface. Although the Coal Board only cater for an annual 15 million tons of opencast coal—Westfield is likely to yield an annual 600,000 tons of saleable coal—private sources have estimated that with the assistance of plant now available double this figure, or 30 million tons a year, is currently an economic possibility.

Opencast mining, which in fact produces coal in no way generally inferior to deep mining, starts off with the great advantage that it has no long-term labour problem to overcome, either past or future. Production efficiency turns on the successful deployment of large excavators and haulage units and the initial experience being gained at Acorn Bank, where the weekly objective is 16,500 tons of graded coal, is the subject of an article elsewhere in this issue. Suitable excavators cost around £½ million a time and British experience in this field of machinery building might be better remembered.

Requisition of the land for opencast coal mining is still something of a problem, though not, fortunately, a technical one. Restoration, however, is an engineering problem, but past experience shows that the full cycle until final return to mixed farming generally takes between five and seven years, with serious grazing being commenced after three or four years. During restoration improved surface gradients can be laid and the top soil—which is stored separately—can be cleaned of stones; so far, the coal seams have been so thin that the final top level has been unaffected and quite adequate consolidation has been obtained to eliminate the possibility of later settlement. At Westfield, however, the coal crop is likely to be so good that the final ground level will be lowered—but there won't be any unsightly slag heaps to mar the countryside.

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Diesel Engines in Iraq

The world markets for oil engines used for industrial and marine applications continue to expand. Exports in 1955 totalled £29·6 million, and were running at an annual rate of £35 million during the first four months of this year. Lord Hives, chairman of Rolls-Royce, mentioned at the annual general meeting of his company last week that Rolls-Royce oil engines were being exported to 53 countries "extending from the Arctic circle to New Zealand." The planned output in 1957 is to be 50 per cent. greater than in 1956, which was itself more than twice the 1955 figure. This rate of expansion may be exceptional, since Rolls-Royce are relatively new in this industry, but there is little doubt that the world's need for small power units, particularly those in the 5 to 50 h.p. group, is growing rapidly. The part played by under-developed countries is becoming more important and in this connection a report on the Iraq market prepared by Mr. Malcolm Logan, director of the British Internal Combustion Engine Manufacturers' Association (BICERA) is of interest.

Mr. Logan visited Iraq to assess the nature of demand and the competitive position of British manufacturers. He found an expanding demand based on a fast growing need for small to medium power units to drive pumping plants (for irrigation), municipal water systems and plant for local power generation. "Local demand for power is outstripping the development of centralised power systems." In general the demand is typical of countries where skilled maintenance engineers are a rarity; there is a strong preference for the slow-running, horizontal types of engines which can keep going in all kinds of conditions and with little attention. Gradually, however, the country is turning over to more advanced types of engines. German sales engineers have been pushing hard to expand the sales of air-cooled and high-speed vertical water-cooled Diesels, with some success. Mr. Logan says there is a great deal of scope for "further education" and urges British manufacturers to visit the country and take a more vigorous part in the education process: "the German sales drive is also expressed in terms of the quality and quantity of sales-cum-service personnel which they are putting into the territory. There is local criticism of U.K. efforts in this direction and of the fact that relatively little 'top brass' of industry is visiting this important market."

Other important points made by Mr. Logan are that the market calls for credit facilities and that conditions of contract are getting harsher: "it might pay competitors of all nationalities to consider joint action." Also that good agents are hard to find, and that there is a need for more technical training on the spot. The industry should take his remarks to heart. Although they have the major share of the market (exports in 1955 totalled £674,000) German and American competitors are making rapid progress.

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Airs and Graces

The technically minded gramophone enthusiast seems often to be concerned more with the reproductive quality of his machine than the excellence of the music. Now perhaps we shall meet too the collector of pictures, who, having invited us to view his Hogarth etching, will say: "Ah! but note the vigour of the air conditioning."

Recently, the National Gallery reopened six more exhibition rooms which have been closed to the public since the war; three of these are air-conditioned and complete the group of six planned in 1946. A fundamental danger to the preservation of pictures is the variation in relative humidity of the normal atmosphere, but by proper use of air conditioning this hazard can be avoided. Air is cleaned by passing through a cloth screen specially woven to provide the maximum interception of dust particles and then goes through a water-spray chamber. It is thus virtually freed from dust, while the ammonium sulphate content is much reduced. The relative humidity of the air is closely bound up with its temperature, and to maintain it at a constant level both heating and refrigeration are required.

"Now," as Sir Philip Hendy, the Director of the National Gallery, observed, prior to the opening, "Raphael will suffer less from blisters, once he has been liquored up with a decent atmosphere." He also said that if air-conditioning plant had been introduced 100 years ago—steam operated plants were apparently then available—there would be fewer troubles now, and concluded by remarking on the continued service to the public provided during the War by the National Gallery, which like another famous establishment, was entitled to the slogan "We never closed."

Now, too, thanks to the ventilation engineer and the Ministry of Works, we shall be able to look at pictures without their protective shields of glass, and when we stand before that magnificent Toy-Town scene "The Rout of San Romano," by Uccello, we shall see, not incongruous reflections of ourselves, but the battle itself. Once more the engineer has brought succour to the graceful arts, justifying perhaps a revised motto "Science for Art's Sake."

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Cold Comfort from Quantas

The British aircraft industry had two comforting thoughts exploded last week by Mr. O. C. Turner, chief executive and general manager of Quantas Airlines. Despite the cancellation of the V-1000 project and the rapid development of the long-range American jets, aircraft manufacturers have been consoling themselves with the thought that the British industry has a good lead in fast and flexible gas-turbine aircraft—the Viscount, Vanguard, Britannia and Comet. (Last week the continued success of the Viscount was further underlined by seven orders from Lufthansa.) Mr. Turner, however, pointed out that careful study had in fact shown that the large new American civil aircraft could be used, if required, for short and medium-range work, as well as for long hops. Expanding on this subject, he asked why B.E.A. had not invested in the Comet 4 and pointed to the example of the French Caravelle jet, at present being route-tested for medium-range work.

The second important point raised by Mr. Turner was that it was useless to rely upon cheap long-range flights at the sacrifice of speed. "The public goes for speed," he said, "and it is not much good going for the cheapest aircraft if it is empty." For this reason, he doubted whether the Britannia is going to be a conspicuous success in the future against the speedy, if more expensive, Boeing 707 and Douglas DC8—even although the Britannia should be delivered ahead of the other two. Quantas had at one time been interested in the Britannia, but delivery delays had effectively dampened their interest and rumour currently has it that the Boeing 707 will in fact be their choice. Mr. Turner claimed that the United States industry was far ahead owing to its competitive atmosphere, whereas British aircraft manufacturers, while ostensibly competitive, in fact enjoyed a large measure of protection. This makes queer reading when it is remembered that of the 350 or so orders for the Boeing 707, at least 70 per cent. are for the United States Government, whereas only 10 of the Britannia sales so far have been to the R.A.F. and the Ministry of Supply. Nevertheless, Mr. Turner has a very real point in that even when production lines are fully built up, the Bristol Aircraft Company, Limited, can expect an annual output of only some 50 to 60 aircraft. The American rate is probably three times as great.

Possibly the answer lies in the suggestion made by Sir Roy Fedden in January, 1956, to the Institution of Production Engineers when he said that the main trouble with the British

"ENGINEERING" STARTS A NEW SERVICE

Technical and Commercial Intelligence

ENGINEERING is starting a new service—Engineering Intelligence Service—which will give information on questions connected with engineering and allied subjects.

With the increase in specialisation and the greater use of scientific and technical knowledge the need for adequate sources of up-to-date information becomes more insistent. For anyone occupied with the day-to-day running of a business or department, it is often difficult to find time to carry out an adequate survey on which to base decisions on future policy. E.I.S. will carry out such surveys and provide reports on questions of research, design, production, marketing and management. A fee will be quoted before the work is commenced.

All inquiries should be addressed to Engineering Intelligence Service, 35 and 36 Bedford-street, Strand, London, W.C.2.

aircraft industry was the dissipation of scarce effort on a multitude of projects. The problem of shortages of engineers is shared by many industries, but in none more than in aircraft is it made worse by scattering them thinly over the ground in a multiplicity of projects.

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Progress on Rail

Addressing the Tees-side and South-West Durham Chamber of Commerce on June 13 Sir Brian Robertson, the chairman of the British Transport Commission, took the opportunity to make a number of points about the modernisation of the railways. After the recent ill-conceived pronouncements from another quarter about the rate of rising efficiency on the railways and the perpetual flow of adverse statistics which the Commission has to endure at this stage of its career, a few quietly spoken words about progress of modernisation call for comment.

Speaking about the pace of change on the railway system Sir Brian said " the change will come and it will be dramatic but it will take some time " and he then went on to say that a stable Government policy to support the railways, especially in the provision of capital, is absolutely essential. There are fortunately signs that the Government are fully aware that cuts in capital expenditure aimed at reducing the burden on the economy will no longer achieve their end if they include an ill-timed swipe at the transport system—whether it be the railways or the roads. It is, however, essential to keep the further provision of capital in the forefront of public discussion. The transport system, including the railways, must now receive a high priority if the country's communications are not to be smothered by the sheer density of traffic or crippled by the age of the equipment which has to transport it.

Sir Brian went on to say that British Railways are ahead of most large organisations in developing electronic machines and computers for financial and statistical work. He was able to report good progress on palletisation, an aspect of transportation on which the railways have been trying to secure the co-operation of their customers for a number of years now, and he went on to say that there was still too much drudgery in many railway jobs and that he would favour an increase in modernisation to end this, thereby increasing efficiency.

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A Brake on Enterprise

The effect of the credit squeeze on the rate of industrial expansion was the main theme of Lord Piercy, chairman of the Industrial and Commercial Finance Corporation, in his annual statement published last week. He fears that " the atmosphere which has been generated by credit restriction, the extension of the range of the Capital Issues Committee control, and the replacement of the investment allowance by a reversion to the scheme of initial allowances of six years ago " may have slowed down a movement towards extended capital equipment which became strong about 18 months ago. Lord Piercy made the point that it is the rapidly expanding company which suffers most from credit restriction. This will be keenly felt by many engineering concerns which have forged ahead in recent years: to keep the company solvent is taking more of the time and energy of the managing director than the direction of its affairs. The credit squeeze may well go further and put the enterprising company out of business, or impose a timidity which had become characteristic of British industry until 1955.

I.C.F.C. was founded in 1945, by English and Scottish banks to provide long-term finance for medium-sized firms. Since that time the corporation has invested nearly £50 million, of which £32 million is outstanding at the present time. About 30 per cent. of this—£9½ million—is invested in the engineering, shipbuilding and vehicles industries and another £1 million in the manufacture of scientific instruments.

The Corporation is itself subjected to a double squeeze. On one side by the tighter controls on investment by the C.I.C. and the extension of this control to amounts above £10,000 (Lord Piercy would like to see this extension cancelled) and on the other side by a restriction by I.C.F.C's own shareholders on the provision of new money. The Corporation's main source of finance is therefore repayments and realisations of investments, which will probably slow down as the companies it has sponsored lose access to other sources of finance. There is therefore a long queue of applicants and I.C.F.C. has had to " select rigidly even among propositions of a highly eligible kind." The suggestion is that there is in fact " a strangulation of needed investment."

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End of a Polite Gesture

Last January the Ballast, Sand and Allied Trades Association paved the way along with the Cement Makers' Federation in agreeing to pegging prices for six months in an effort to set an example of price stabilisation. Last week the sand and ballast makers let it be known that their prices were not likely to remain pegged after the end of this month, and there is further indication that the cement makers will have made a similar decision before this issue is printed. The announcement, by a touch of irony, coincided almost to the day with a meeting between the Government and British industry (as represented by the Federation of British Industries and the British Employers' Federation) when the recent flow of price increases by nationalised industries was criticised by private enterprise. It is understood that one of the consequences of this meeting will be for the Government to invite representatives of the nationalised industries and of private industry to a joint meeting and the Central Electricity Authority has made a shrewd tactical move before this meeting in calling on its area boards for a price 'freeze' until March 1957. The last meeting was the sixth in a series which the Prime Minister has had with leaders of industry and the unions; if meetings alone could stabilise prices, the economy should have reached something approaching rigidity by this time.

It is true, of course, that the pressure of rising costs has been intensified by the inability of the nationalised industries, particularly transport, to keep prices down, but examples are not lacking of where good management has successfully fought rising price trends and has not taken the easy way out of mollifying labour or condoning inefficient buying. When the research ship " John Biscoe " was recently launched at Glasgow the managing director of Fleming and Ferguson, Limited, of Paisley, said that his company had pursued a policy of fixed prices ever since the end of the war—and that included this latest ship. They had been assisted, he added, by the fixed price undertakings given to them by their major machinery contractors and by certain sub-contractors; it had not been easy to pursue this policy and the pressure of costs had recently been particularly severe. While full credit must be given to those who have publicly endeavoured to stabilise prices, even greater credit must be given to those companies which have quietly and efficiently fought rising costs over recent years without writing escalator clauses into their contracts.

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A German Engineering Centenary

The Verein Deutscher Ingenieure, the leading German engineering institution, recently celebrated the centenary of its foundation. The proceedings included meetings extending over several days at which lectures were delivered on a number of general and specialist subjects, automatisation finding a prominent place among the latter. In addition, a number of visits were paid to reconstructed buildings in Berlin, and to research laboratories and factories in the neighbourhood, while the social side was not neglected. According to a commemorative booklet the Verein was inaugurated at Alexisbad in the Harz on May 12, 1856, when the international exhibitions of London in 1851 and of Paris four years later had called attention to the likelihood of great engineering developments. The protagonists in this enterprise were Richard Peters, Friederich Euler and Franz Grashof, all of whom were mining engineers, and five local centres of activity were established—in Düsseldorf, Berlin, Aix-la-Chapelle, Saarbrücken and Dortmund. It was also decided to publish a monthly journal and to organise meetings for the dissemination of technical information.

At first the membership increased slowly, but accelerated after 1910 and had reached no less than 58,000 at the beginning of the 1939-45 war. In the meantime the headquarters had been established in Berlin, where the administration was conducted for many years by the well-known engineering historian Conrad Matschoss, assisted later by A. Meyer and W. Hellmich.

A difficult question which arose about this time was how far the Verein should deal with political and economic questions rather than solely with purely technical matters. This problem had not been solved when the Second World Power Conference took place in Berlin in 1930 and was further complicated by the action of the Hitler regime in excluding numerous members for political and racial reasons. As a result of this policy and of Allied action (which destroyed the headquarters building) the Verein entered a period of stagnation after the end of the war. Recovery has, however, taken place during the past ten years and the membership is now rather over 32,000. The Verein has therefore experienced both success and vicissitudes, but those who now control its destinies are working energetically to ensure that it is fully representative of the German engineering profession. If the past, as disclosed in the commemorative booklet, is any criterion, this aim should be accomplished.

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A New Electronics Concern

The formation of a British subsidiary has been announced by the Benson-Lehner Corporation of Los Angeles. This company specialise in the manufacture of data-processing machines for use with electronic instrumentation and machine-tool control gear. So far they have not exported very much to this country, due mainly to restrictions on dollar imports. The head of the British company will be Mr. E. J. Petherick who was for seven years (until May this year) in charge of the engineering development group in the Mathematical Services department of R.A.E., Farnborough. He was responsible for system specifications and advice on data handling, including machine-tool control systems.

Benson-Lehner say that their British company will be very active, initially, on the provision of staff to assist in the solution of data-handling problems, the sale of machines imported from the U.S. and on service maintenance of Benson-Lehner products. In due course manufacture of some of the American range will be started, and there is an intention to make here machines and components for export, " particularly to the United States."

For some time now it has been evident that the building of data-processing equipment for the application of electronic controls to machine-tool operation would follow the spread of automation in manufacturing industry. The Benson-Lehner machines are designed to provide a wide range of systems which can be planned to fit particular needs. It is essentially data-processing equipment, which accepts information, records it and converts it for use in control apparatus. In the U.S. they are used by all principal government and industrial research establishments and it is likely that corresponding organisations in this country will become the first users. Like the electronic computer, the general application of such data-processing machines to industry may still be some way off.

ENGINEERING IN SCOTLAND—3

Some impression of the range of industries covered by Scottish firms is given by this, our third and final article in the series "Engineering in Scotland." It deals with two companies: one concerned with agricultural machinery, the other with shipbuilding and boiler plants. Previous articles have appeared in our issues of June 8, page 461, and June 15, page 489 and have discussed the following firms and their products: John Hastie and Company, Limited (ships' steering gear); Weir Valves, Limited (heavy-duty valves); Martin, Black and Company, Limited (wire ropes); W. and H. Nelson, Limited (electrical switchgear); Redlac Limited (steel fabrication); and the Engineering Division of Keir and Cawder Limited (quarrying industry).

MACHINERY FOR THE FARM

That the name Ayrshire should be primarily associated with a breed of cattle is fair indication of Scotland's interest in farming, and it is not surprising that a firm of agricultural-machinery makers should have its headquarters in the market town of Ayr. Based in the Lowland farming area, Scottish Mechanical Light Industries, Limited, have played an important part in the application of engineering to agriculture, and developed a wide range of equipment for farm use and for dealing generally with agricultural products. Items made include hammer mills, grain blowers and the Scotmec-Oxley moisture meter, some of which are described in the following paragraphs.

Formed ten years ago, Scotmec has always had its main premises in Ayr where it was originally founded, and initially specialised in grain blowers and hammer mills. Later, its activities were extended to include other kinds of agricultural equipment, and by 1953 so much progress had been made that it became necessary to undertake a considerable expansion on the Ayr site. Recently a fire broke out and destroyed part of the works but fortunately, though damaged by water, the new buildings were almost unharmed (see ENGINEERING, February 17, page 152, 1956) and are at present being used for manufacture of components and sub-assemblies and of the Scotmec-Oxley moisture meter.

GRINDING FOR FARM OR INDUSTRY

Hammer mills constitute an important group of Scotmec products and are made in agricultural and industrial ranges of from ¾ h.p. to 60 h.p. They may be used to grind materials as fine as wholemeal flour for human consumption or as tough as aluminium swarf, and such other commodities as oats, beans, hay, oil cake, limestone, chemicals, plastics, paper and sawmill waste. Models with 8, 16, 24 and 32 swinging hammers are built and in each case a choice of power ratings is possible. Stationary units are made in these four main sizes but special mobile versions of the 16 hammer model can be fitted to most standard makes of tractor and are accordingly designed with power take-off drive.

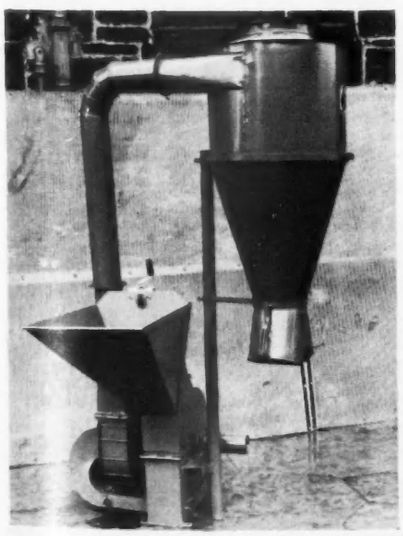


Fig. 1 "Two-Tonner" elevating hammer mill with fan and cyclone. Scotmec mills can be used for grinding wholemeal flour, animal feed and oil cake, industrial materials such as chemicals and aluminium waste.

The basic grinding components of the stationary hammer mills may be arranged in combination with ancillary equipment to form three types of unit: a fanless model which delivers the grain under gravity to a mealchest or conveyor; a second fanless model mounted on a stand, pouring directly into sacks; and an elevating model with fan and cyclone, which utilises the entire airflow to draw the fine ground particles through the screens without overheating, so increasing the grinding efficiency. It is this version that is used for tractor mounting. Fig. 19 shows the 24 hammer "Two-Tonner" model fitted with fan, cyclone and double-bagging outlets and giving a maximum output with $\frac{3}{16}$ in. screens of 3,300 lb. of wholemeal wheat flour per hour.

NON-MAGNETIC ELIMINATOR

In all models the swinging hammers are four times reversible and rotate at 2,800 to 3,000 r.p.m., shattering the material by impact. A non-magnetic eliminator is built into the mill casing and traps any hard pieces, ferrous or non-ferrous, so reducing risk of damage. In addition, an adjustable grain hopper or a combined chute hopper with micro-feed-rate setting is fitted to all mills; once set, these ensure an even automatic feed of grain to the mill, freeing the operator from further attention to feed rate or tractor throttle. A range of 13 screens is provided, with holes from 0·0235 in. (grinding for human consumption) to 1¼ in. in diameter; the perforations cover 78 per cent. of the full circumference thus contributing to the machines' high ratio of output to horse-power.

Apart from the mills already described, Scotmec make a series of five light models known as the "Popular" range, designed for power supplies of from 2 to 8 h.p. Built for pulley drive or fitted with electric or internal-combustion power units, they incorporate eight swinging hammers and a special grinding system with internal fan; in the latter, air recirculates in a closed circuit. They are dust-proof without cyclone or dust filters and grind to any fineness from coarse cattle feed to finest wholemeal flour; in the case of flour the 5 h.p. models give an hourly output of 300 to 350 lb. Finally there is the "Wee Smasher" mill, which incorporates a 7,000 r.p.m. ¾ h.p. motor and includes a grinding outfit with low-level feed hopper, unchokable feed and small multi-bag collector which delivers the meal directly into bags. The "Electromatic" control panel, which is also used with 3 h.p. and 5 h.p. automatic hammer mills, makes the "Wee Smasher" into a fully automatic grinding unit. The all-electric power cut-off shuts off the motor automatically as soon as grinding is completed.

CONVEYING GRAIN BY AIRFLOW

The problem of transporting grain or other granular commodities may often be solved most simply and economically by use of a grain blower; Scotmec claim for example that by use of their equipment grain can be conveyed for as little as a penny a ton. Their smallest unit, which is designed for use with 6 in. diameter piping and operates on approximately 2 h.p., can be fitted with a single or three-phase electric motor or 120 c.c. petrol engine and can convey 35 to 40 cwt. of grain per hour straight up into a 20 ft. silo. Other models ranging in horse-power from 3 to 7½ are made for 8 in. diameter piping and are mounted on stationary or wheeled frames or arranged for attachment to the three-point linkage of tractors. These are constructed in two basic forms: one is fitted with a drive pulley, has a double air inlet (one vent at each side of the fan casing), and employs a rotor comprising a double sided fan; while the other has a single air inlet and a built-in power unit with the fan mounted directly on the drive shaft. The 3 h.p. models in both series can convey 70 to 80 cwt. of grain per hour straight up into a 20 ft. silo. The 420 c.c. motorised version is illustrated in Fig. 20; the box-shaped saddle attachment is a drying hood and will be discussed later.

The Scotmec grain blowers have a number of interesting features including an automatic blast control, which embodies a pivoted flap to shut off the air blast before starting. Since the power consumption is lowest when no air passes through the fan, the control fully protects the motor against overload before conveying begins. When the motor is stopped the flap closes automatically. An adjustable controller is also made for regulating the air volume. Another feature of these machines is the Scotmec "Venturi" grain injector, which is designed

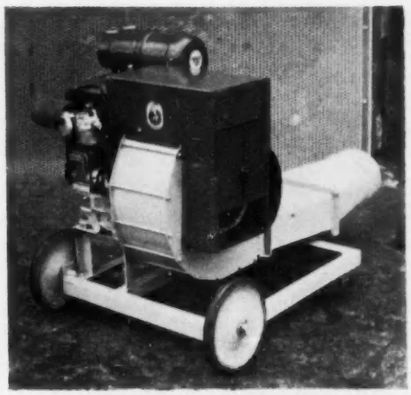


Fig. 20 Dual-purpose grain-blower with built-in 420 c.c. engine and drying hood. As a conveyor it can lift more than 70 cwt. of grain per hour straight up into a 20 ft. silo, while as a dryer it can deliver 2,100 cub. ft. of heated air per min.

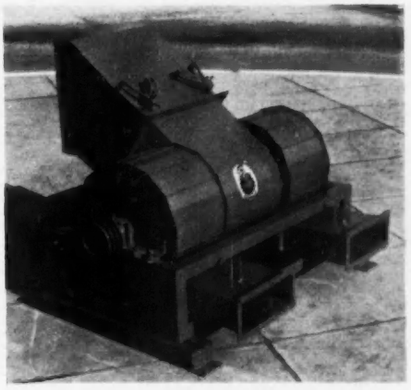


Fig. 21 The Scotmec BLT 10 twin blower can be connected in tandem to deliver grain to considerable heights or in parallel to convey large volumes. Driven by a Power-Pack with patented heat-exchanger system, which recovers waste heat from the engine, it can be converted into a dual purpose grain conveyor and dryer. 25 to 30 kW heat energy is required in addition to 10 to 15 h.p. mechanical energy for driving the blowers.

to give maximum output without clogging or bruising of the grain. Where several silos have to be filled or emptied by one blower the "Ducturi" system may be used; this employs a continuous pipeline, in which pressure losses are minimised, and may be used also for transferring grain from bin to bin.

Scotmec have recently introduced two high-pressure high-volume twin blowers, each of which may be used in three different ways. Firstly, they can operate in tandem with the outlet of one blower connected by means of a tandem duct to the air inlet of the other so that the pressures become additive; the blower can then convey grain to great heights and distances. The air volume, however, remains the same and for this purpose 8 in. diameter piping is used. Secondly, the blowers can be joined in parallel by means of a Y-connector; in this case the pressure remains constant but the air volume is doubled and consequently large volumes of grain may be carried rapidly over normal distances. With this arrangement 11 in. pipes are necessary. A third system provides separate air streams; one blower is used for conveying and the other simultaneously for drying, using an electric heater or the waste heat from the engine. Piping 8 in. in diameter is employed for this application.

One of the two twin blowers is illustrated in Fig. 21. Known as the BLT 10, it can deliver up to 5,000 cub. ft. of air per minute against a pressure of 5 to 7 in. water gauge and is fitted with a pulley to take a belt drive from a 10 h.p. electric motor. The BLT 7½ h.p. blower can deliver 4,000 cub. ft. of air per minute and comprises two independent single-entry blowers mounted on opposite ends of the 7½ h.p. motor shaft.

Fig. 22 The sharp probes of the Scotmec-Oxley moisture meter can be inserted into a sack of grain and by means of resistance measurements give an instantaneous reading of the moisture content present.

It is of interest that both these units can aslo be used for grain drying. A 6½ kW heater fitted to one blower inlet of the BLT 7½ model will raise the temperature of 2,000 cub. ft. of air per minute by 10 deg. F., and if necessary heaters can be attached to both blowers and switched off—but not removed—when the plant is used simply for conveying. An 18 kW heater performs a corresponding duty for the BLT 10 machine.

CONSERVING HEAT FOR CROP DRYING

A special heat exchanger system which can be fitted to the inlet of the BLT 10 to form a composite "Crop Dryer-Power Pack" has also been developed by Scotmec. This unit utilises all three sources of waste heat: stray losses from the engine, the exhaust gases and the engine cooling water, and thus recovers over 25 kW of heat for drying purposes without sacrificing any of the 10 to 15 h.p. power to drive the twin blowers. The hot cooling water from the engine passes to a cylindrical contra-flow heat exchanger where it receives further heat from the exhaust gases, bringing it nearly to boiling point; it is then carried to a second heat exchanger where the accumulated heat is transferred to the incoming air, which has already been heated to some extent in its passage over the engine unit. In this way considerable economies are effected.

The principle of converting grain blowers into dryers has also been found applicable to the smaller machines. In March, 1955, for example, a National Agricultural Advisory Service officer wrote to Scotmec to report the successful use of the 420 c.c. grain blower for grain drying: "During last harvest I checked one of your units driven by a B.S.A. engine, this having ducts fitted from the engine to the fan inlet. I found that when ventilating through a 2 in. Leca floor having a 4 in. air space underneath the floor and a grain depth of 8 ft. in a 10 ft. diameter silo, we got a good 10 deg. rise and an air speed of up to 20 ft. per minute per square foot of floor area. Drying was very satisfactory."

Based on this information, a series of controlled experiments were carried out in the Scotmec works with the object of ascertaining the maximum amount of waste heat that could be recovered from the engine without entrainment of exhaust fumes. The result was the Scotmec drying hood, shown fitted to the 420 c.c. blower in Fig. 20. Designed to give unimpaired efficiency of the blower when used for grain conveying, the hood collects the air drawn over the air-cooled engine and the hot exhaust pipe (without taking in the fumes) and leads it into the blower inlet. It is fitted with a regulating slide, which allows cold air from the atmosphere to mix with the hot air, so that the temperature of the drying air can be set as required. The slide is left fully open during conveying. It has been estimated that the combined unit will deliver heated air at a rate of from 1,500 to 2,100 cub. ft. of air per minute with its temperature raised by 10 to 18 deg. F.—enough to dry grain in from one to two silos.

TESTING MOISTURE CONTENT

Dryness is an important consideration when grain is bought or sold for not only is the moisture content a measure of the keeping quality but the quantity of water present is also necessarily included when prices are calculated. An instrument capable of providing a rapid and accurate indication of grain moisture content without sampling has been developed by Mr. T. A. Oxley of the Department of Scientific and Industrial Research and is now being produced commercially by Scotmec. This instrument embodies nine pointed steel probes, each approximately 8 in. long, which can be inserted through the texture of a sack and are arranged parallel to each other on an insulating base. These are cross connected electrically and linked to a small built-in generator which on turning a handle applies 500 volts across pairs of probes. The resistance between these electrodes is measured by means of a "Megger" ohmeter giving a direct reading of moisture content. No battery or external power supply is required. Various models calibrated for different kinds of grain and ambient temperatures are made, and a correction dial for use where conditions vary can also be fitted. The production model of the instrument is shown in Fig. 22.

In addition to the equipment already described Scotmec manufacture grain bins; transport platforms, boxes and pick-ups for attachment to tractors; husk ejectors; stock feed mincers; geared pulley units; silos; grain cleaners; and various auxiliary items.

SHIPS AND BOILERS

The Clyde has served as catalyst to a large sector of Scottish industry and though we have strayed some way from Clydeside in these articles, it is fitting that in the last of the series we should return to its banks, and consider one of the river's many shipyards. Strictly, Yarrow's are not a Scottish firm at all in origin, but it is in the Glasgow suburb of Scotstoun that the company has prospered for the last 50 years. In addition to their marine work, they have made a very considerable contribution to the development of the land boiler, and also carried out extensive research.

The firm of Yarrow and Company, Limited, was founded in 1866 at a small yard in the Isle of Dogs on Thames-side by Alfred Fernandez Yarrow (later to become Sir Alfred Yarrow, Bt.), and the first vessels constructed comprised small steam-driven launches, shallow-draught paddle steamers and stern-wheelers. In 1868 the first naval order—four gunboats for Brazil—was obtained. Other landmarks include the company's first iron hull, which was built in 1870, and the Yarrow marine water-tube boiler, developed between the years 1888 and 1890. In 1907 the company moved to Glasgow and now occupies a site on the Clyde at Scotstoun with a river frontage of 1,000 ft.

The yard suffered severe damage during the air attacks on Glasgow in March, 1941, and an extensive programme of reconstruction and modernisation has been carried out since the end of the war. The shipyard now has four main berths each served by tower cranes and capable of taking ships up to about 400 ft. in length and 53 ft. in breadth and also a number of others for shallow-draught vessels. After launching, ships are fitted out in a covered-in wet basin, and prefabrication of large hull sections is carried out in a new shop set aside for that purpose; this is also large enough to permit the construction, under cover, of complete vessels which are to be dismantled for sending abroad.

The engine shops, which are fully equipped for the production of steam turbines, engines and other plant, are capable of an annual output totalling 300,000 h.p., while land and marine boilers of all sizes are built in the boiler shop which was recently extended and now covers an area of 100,000 sq. ft. The company is on the British Admiralty and Lloyd's lists of approved welded pressure-vessel manufacturers and a fully equipped X-ray and mechanical testing laboratory is available, in which all classes of non-destructive testing and inspection can be undertaken.

NAVAL CONSTRUCTION

From their earliest days Yarrow's have been closely associated with naval construction and have played an important part in the development of the smaller types of warship. The first destroyers to be so called were built by them in 1892 when two ships Havoc and Hornet, were ordered by the British Admiralty. Hornet was the first vessel in the British Navy to be fitted with a Yarrow water-tube boiler, and this resulted in a marked increase in speed. These boilers hare since been fitted in such ships as the Queen Elizabeth, Saxonia and Southern Cross. In 1912 the British Admiralty ordered H.M. ships Firedrake, Lurcher and Oak to the company's own design, which entirely outclassed the existing 27 knot vessels by achieving speeds of over 35 knots. Another advance was made by the construction of H.M.S. Tyrian, built in 1919, which maintained a speed of 40 knots for four hours during the official trials; this was stated at the time to be the highest official speed ever maintained by any warship in the world.

Yarrow and Company have built naval vessels for many foreign countries including the Argentine, Brazil, Italy, Portugal, Sweden, Turkey, Yugoslavia, and others. Of particular interest are three customs and patrol gunboats built to the order of the Colombian Government. Although of moderate dimensions and with a draught of only 2 ft. 6 in., these vessels crossed the Atlantic under their own power without escort.

Yarrow-built naval vessels completed during the wars of 1914-18 and 1939-45 formed an aggregate of 88 ships having a total displacement of over 90,000 tons and a horse-power total of 1,400,000. During the 1914-18 war, the output included 33 destroyers and 16 gunboats and the company was responsible for the famous "Tigris" flotilla which played such an important part in the Mesopotamian campaign and the capture of Baghdad. The Yarrow

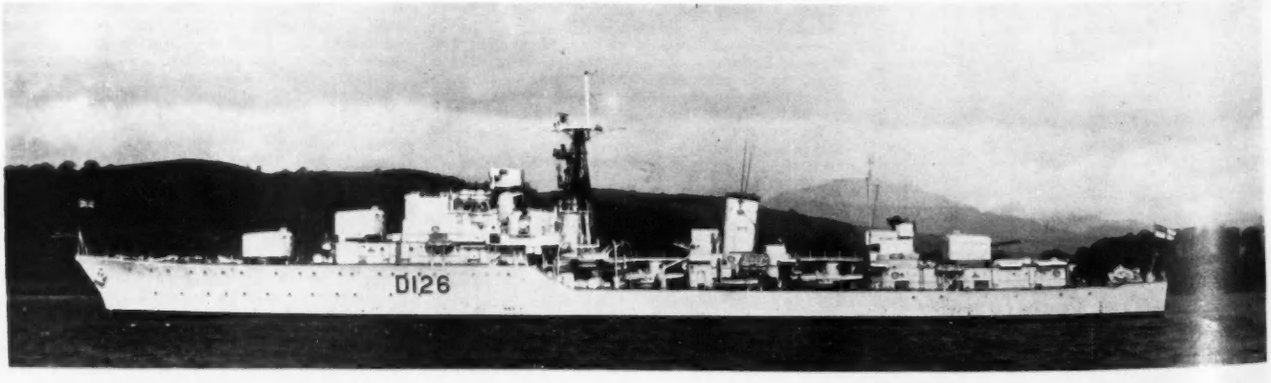


Fig. 23 "Daring" class destroyer H.M.S. "Diana". Length 390 ft., beam 43 ft. and standard displacement 2,610 tons. Yarrow and Company have long been associated with destroyers and built the first vessel of this kind to maintain an officially recorded speed of 40 knots (H.M.S. "Tyrian", 1919).

contribution to the Royal Navy during the 1939-45 war included one flotilla leader, 19 destroyers, 8 sloops and 4 gunboats and conversion work including tank landing craft and flak ships. Between the two wars six special gunboats were supplied to H.M. China Station.

Since 1945, two "Weapon" class destroyers, H.M.S. Battleaxe and H.M.S. Broadsword, have been constructed for the Admiralty and more recently two "Daring" class ships, Decoy and Diana. H.M.S. Diana is shown in Fig. 23. The company has also acted as the parent firm for the construction of a number of seaward defence boats, two of which were built at Scotstoun. H.M.S. Hardy, the first of three new frigates, has recently been handed over to the Admiralty. Of the other two, H.M.S. Keppel has completed sea trials satisfactorily, and H.M.S. Malcolm is fitting out. The latest order secured from the Admiralty is for a prototype frigate with geared steam turbines and gas-turbine boost.

The firm recently made an important contribution to the progress of naval engineering, when the Canadian anti-submarine destroyer escort vessel H.M.C.S. St. Laurent successfully ran her trials at Montreal. The main machinery of this warship was supplied by Yarrow and Company and is entirely of British design. The turbines and water-tube boilers were manufactured at Scotstoun and shipped, with the rest of the main machinery, to Montreal. H.M.C.S. St. Laurent, the prototype of her class, is described by the Canadian Naval Authorities as the smallest ship capable of maintaining functional fighting efficiency against the most modern submarine or its immediately foreseeable successor under the extreme weather conditions which prevail in the North Atlantic.

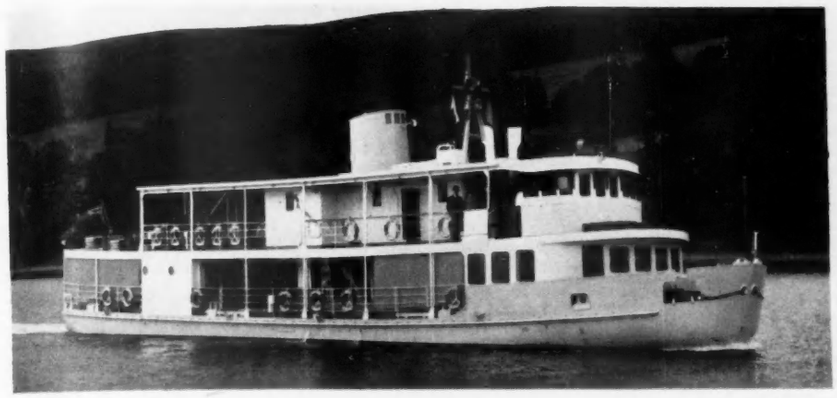


Fig. 24 "Itu", a twin-screw raised-propeller motor passenger vessel built by Yarrow's for service on the Calabar and Cross rivers in Nigeria. Her principal details are: length 110 ft. 6 in., beam 21 ft., draught 2 ft. 6 in. and speed 11½ m.p.h. The propellers work in tunnels within the hull and can therefore have diameters exceeding the draught of the vessel.

COMBINED GAS AND STEAM TURBINES

An interesting development since the end of the last war has been the setting up of a Yarrow-Admiralty research department for the design and development of high powered propulsion machinery for the Admiralty. Recent installations which have been conceived and designed by the research department in conjunction with the Admiralty include those for the Whitby and Blackwood class anti-submarine frigates, which incorporate an advanced design of boilers and geared steam turbines. In addition to designing this plant, the research department has organised full-scale shore trials of a prototype shaft set of machinery. A subsequent full-scale shore test of a more powerful and advanced steam machinery installation is at present in hand.

More recently propulsion-machinery installations of a new and revolutionary type for two new classes of ship have been developed. Highly efficient geared steam-turbine plant is used in combination with gas turbines. The gas turbines provide a high concentration of power in a very compact form and will be used to boost the steam turbines for sustained bursts of high speed. These highly efficient light-weight and compact installations will enable the new ships to carry much more fighting equipment than would be possible with orthodox machinery. Nuclear energy will play an increasing part in the future work of the research department.

SHALLOW-DRAUGHT MERCHANT SHIPS

From foundation the firm has specialised in the design and construction of shallow-draught vessels and over 1,000 ships of this type have been built for many parts of the world including the Amazon, Nile, Niger, Zambesi, Ganges, Irrawaddy, and Yangtze rivers, and lakes Nyasa, Titicaca and Tanganyika. They include sternwheelers, side-paddle steamers, tunnel-screw vessels of specialised design, and open screw steam and motor ships of conventional design; if necessary abroad they are supplied in sections for re-assembly.

TUNNEL SCREW

Yarrow's pioneered the development of propellers working in tunnels within the vessel's structure, making possible the use of screws having a diameter greater than the draught of the vessel. The subsequent introduction of the Yarrow automatic hinged flap fitted at the after end of the tunnel greatly improved this design.

An interesting link with the earlier history of the company was the construction in 1949 of the twin-screw motor vessel Ilala II. In 1875, in fulfilment of the often expressed wish of the explorer David Livingstone, a small steamer was built by Yarrows at Poplar for the first Scottish Mission in Central Africa. This was named Ilala after the spot where the missionary's heart was buried. After shipment in pieces to the mouth of the Zambesi, the vessel was assembled and sailed up that river and along the Shire river to Murchison Cataracts where she was taken to pieces again and carried over land by natives to the Upper Shire at Matope. Here she was again rebuilt and eventually sailed into Nyasa some seven months after leaving England. The Ilala was believed to be the first steamer to be launched on an African lake and in the succeeding 28 years did good work in putting down the slave trade and furthering the work of the Scottish Mission there.

Ilala II, built for the passenger and cargo service of Nyasaland Railways, was named after her historic predecessor. After completion at Scotstoun she was dismantled and shipped to Beira and from there was taken by rail to the lake where she was re-assembled.

MAID OF ASHTON

In 1953 the Maid of Ashton, a twin-screw motor ship of 508 tons gross was completed for British Railways (Scottish Region). Other recent contracts include three paddle steamers for services on the river Ganges and a pusher tug for the river Niger. The former, with a draught of 4 ft. 3 in. and a speed of 12 knots, were strengthened and boarded up to enable them to make the voyage to India under their own power. The tug, Adama, is a raised-propeller vessel designed to push a train of eight 200 ton capacity barges, carrying petrol 1,200 miles up the Niger and Benue rivers to Garoua in the French Northern Cameroons.

Two twin-screw river Diesel vessels, La Pedrera and Rocafuerte, were recently completed for the Peruvian Government. After running trials in the Clyde, these vessels, each having a lifting weight of about 110 tons, were shipped complete as deck cargo. On discharge afloat at Belem, Brazil, the vessels proceeded under their own power to Iquitos on the Upper Amazon, covering in all about 6,500 nautical miles to reach their destination. The tunnel-screw passenger ferry Itu, built for the Elder Dempster Lines, Limited, for their service between Calabar and Itu in Nigeria, was divided after trials, into two floatable sections and shipped as deck cargo in the owner's liner Onitsha. It is illustrated in Fig. 24.

BOILERS FOR POWER STATIONS

The first Yarrow land boiler was commissioned in 1922 in the Dunston power station of the North Eastern Electric Supply Company, and is still in service. Since then manufacture of land boilers has formed an increasingly important section of the firm's activities. In addition to the many industrial and power-station installations in the United Kingdom, boilers have been exported to most parts of the world. Recent installations are those for Clyde's Mill, Plymouth, Roosecote, Bold and Hayle power stations in this country, for Bulawayo, Shabani and Umtali power stations in Southern Rhodesia and Pretoria B and Windhoek power stations in South

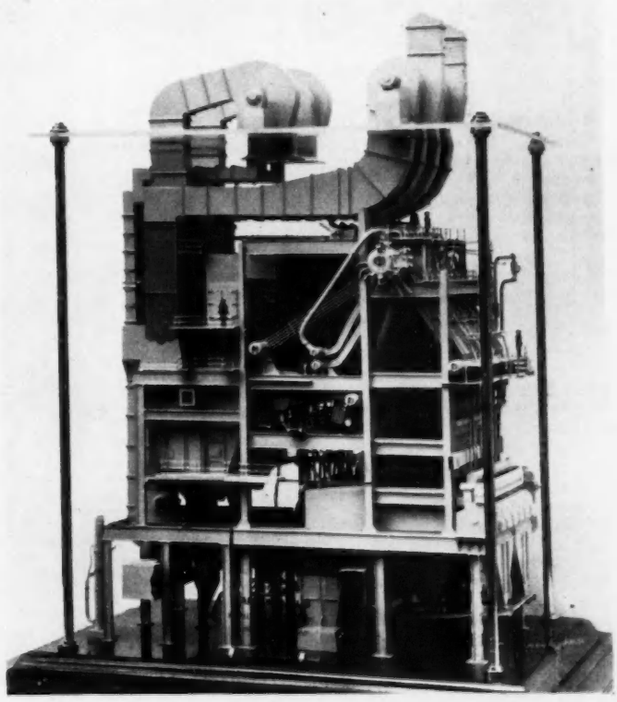


Fig. 25 Model of one of the ten 210,000 lb. per hour stoker-fired boilers made by Yarrow and Company for the Pretoria B power station in South Africa. Yarrows have been making land boilers since 1922 when the first was commissioned in the Dunston power station of the North Eastern Electric Supply Company.

Africa. A model of one of the ten 210,000 lb. per hour stoker-fired boilers being made for Pretoria B can be seen in Fig. 25. Industrial plants are also built, and those already completed include units for Paton and Baldwin's new factory at Darlington, and the Pretoria and Vanderbijl Park Steelworks of the South African Iron and Steel Industrial Corporation, Limited. Current contracts include six 200,000 lb. per hour boilers for the Dalmarnock power station of the South of Scotland Electricity Board (Fig. 26), and a 550,000 lb. per hour boiler for Elland power station.

BOILER RESEARCH

In 1949 on behalf of the British Shipbuilding Research Association and in collaboration with the staff of the Royal Technical College, Glasgow, the company designed and installed at the College an experimental boiler for research work on the effect on natural circulation of uniform and non-uniform heat input at steam pressures up to 1,500 lb. per square inch. Provision is made in the design for altering the length, diameter and inclination of the tubes and also the heat input rate. The plant may be operated as a simple closed system in which the steam is condensed in a condenser integral with the steam drum, the condensate refluxing back into the steam drum; or on the more orthodox system comprising a hot well, feed pump and feed heater. In this case the steam, after passing the feed heater, enters an atmospheric condenser and flows through the measuring tank to the hot well. A great deal of valuable research work has been carried out by the College on this unit and the work is still proceeding.

Another interesting unit has just been supplied for experimental work in the Heat Engines Research Laboratories of the Department of Scientific and Industrial Research at East Kilbride. This unit is designed to supply steam for research purposes at a pressure of 750 lb. per square inch at different temperatures ranging from a maximum of 750 deg. F. down to approximately saturation temperature.

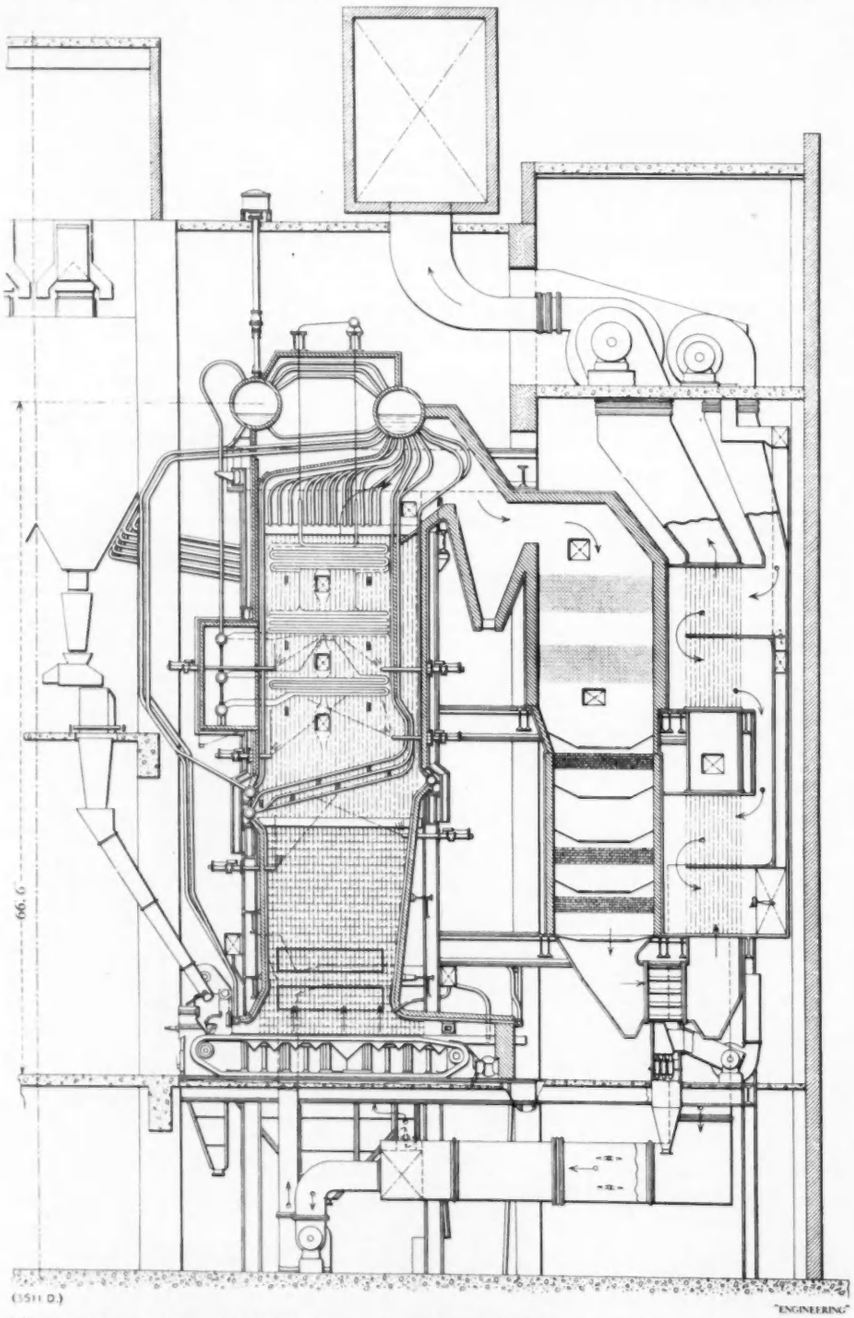
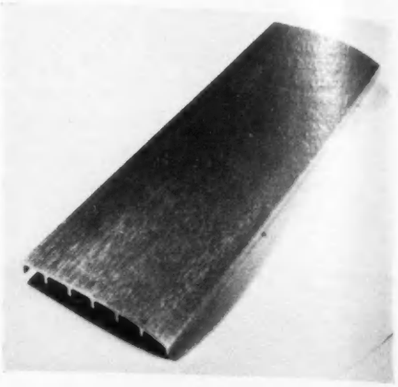


Fig. 26 Cross-section of 200,000 lb. per hour Yarrow boiler, six of which are to be installed in Dalmarnock power station of the South of Scotland Electricity Board. In addition, a 550,000 lb. per hour boiler is to be built for Elland power station.



Model wing panel showing an " as machined " surface; a V-point tool was employed in this instance to emphasize the lines of generation.

MACHINE TOOL FOR GENERATING AEROFOILS

In about 12 months' time, a new machine tool for generating full-scale wing panels to aerofoil shape, which can be operated by an unskilled worker, will be available for demonstration to the aircraft industry at the works of J. L. Jameson, Limited.

The machine has been designed by the Jameson company under the auspices of the Directorate of Aircraft Production Development, Ministry of Supply. In some respects it is similar to designs proposed by both Sir W. G. Armstrong Whitworth (Aircraft) Limited, and Boulton Paul Aircraft Limited in early studies on wing-panel machining.

In the light of past experience it was decided that to attempt to use a milling process to produce a finished aerofoil was unacceptable when producing thin membranes, due to the comparatively large heat input and the hazard of vibration. Moreover, it would appear impossible to obtain a curved and twisted surface, finish-machined, using any milling process.

VACUUM CHUCK

The prototype of the Jameson machine will have a work table 24 ft. by 8 ft. In addition to generating the inside and outside profiles of wing panels, it will generate with equal accuracy a female of the aerofoil, which can be made into a vacuum chuck to hold the panel during the subsequent internal-ribbing operations. An important feature of the design is that the size of the machine can be increased considerably without loss of cutting efficiency.

Model wing panels and mock vacuum chucks have been produced to demonstrate the accuracy of this generating principle. The surfaces of these are " as machined " with no hand finishing and a V-cutting tool has purposely been used so as to indicate the lines of generation, as may be seen in the accompanying illustration. The panel, in addition to being tapered over its length approximately $\frac{1}{4}$ in., has a 13 deg. 11 min. twist; the ribs—both as to lay and thickness—are tapering in the same ratio. The skin thickness also tapers from $\frac{1}{16}$ in. to $\frac{1}{32}$ in. over its full length.

In making provision for stretch-levelled slab as the basic material for this generator the Ministry has had the full co-operation of the Northern Aluminium Company, Limited, and the requisite machinery is being installed in their works. It is hoped that the material suppliers will be able to taper these slabs and to curve them roughly to aerofoil shape before delivery to the aircraft industry so as to reduce the amount of machining required and conserve material.

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LARGE ELECTRIC SYSTEMS

PROGRESS IN EXTRA HIGH VOLTAGE TRANSMISSION

The sixteenth Convention of the International Conference on Large Electric Systems (CIGRE) opened at the Fondation Berthelot, Rue Saint-Dominique, Paris, on May 30 and continued until June 9. The number attending on this occasion established a record and was drawn from the majority of the leading countries of the world, thus emphasising the importance of the subjects that were discussed. To reduce the number of simultaneous meetings papers on more specialist matters are in future to be presented only every four years. Nevertheless, nearly 120 communications covering a wide field were considered by the delegates.

The chair at the opening meeting on May 30 was taken by Mr. R. A. Schmidt (Switzerland), the president of CIGRE, and the Convention was formally opened by Mr. A. Louvain, the French Minister of Industry, who reviewed the progress in electricity supply which had taken place during the past two years. A vote of thanks for his attendance was then proposed by Mr. A. H. de Bast (Netherlands) and Mr. B. Buchert (Finland) on behalf of the French and English speaking delegates respectively.

We give below short accounts of some of the more important papers discussed, although not in the chronological order in which they were presented.

POWER TRANSMISSION AT 220 KV AND ABOVE

A meeting of the group dealing with power transmission lines operating at over 220 kV alternating current was presented with a report by Mr. P. Sporn (U.S.A.), in which he concisely reviewed the developments which were taking place in different countries.

Late in 1957 it was expected that in France 309 miles of existing two circuit 225 kV line would have been converted to 380 kV, leaving 331 miles to be changed. Of the 225 kV lines projected 260 miles would also be converted to 380 kV and a further 475 miles would be operated at that voltage. By 1960 it was expected that there would be 1,475 circuit miles of 380 kV line.

By the end of 1956 it was anticipated that in Sweden 1,620 circuit miles of 380 kV line would be in use, its capacity having been increased by the installation of series capacitors. Connections to 380 kV transformers located underground were made by cables, which in one installation extended directly into the transformer tank without external bushings. Tests had indicated that the surge voltages on modern 380 kV circuit breakers were too low to influence the choice of insulation level if based on the use of lightning arresters and that the maximum length of line on which 380 kV single-pole circuit-breakers could be re-closed was about 150 miles. Bundle conductors did not cause more trouble from snow and ice loading than single conductors. A re-survey of the water power resources in Northern Sweden showed that increased transmission facilities would be needed to deliver energy to the south. System voltages of 400, 500 and 600 kV were being considered and direct-current transmission was also being studied.

In Australia large power developments had led to the adoption of extra high voltage transmission and a 330 kV system was under construction. It was expected to begin operations at 380 kV in Germany in 1957, in connection with which 20 axle railcars with a 220 ton capacity had been ordered for the transport of the transformers. About 160 miles of 287 kV line had been put into operation in the United States during 1955. In the 330 kV class, 1,127 circuit miles of circuit were in operation and a further 265 miles were planned or projected. In addition some 50 miles of 230 kV line were being converted. Voltages higher than 330 kV were being considered.

Dealing with the position of transmission at 400 kV or higher voltages in Sweden, Messrs. G. Jancke and S. Lalander pointed out that the total length of the 400 kV lines now in operation amounted to nearly 1,700 miles, while the maximum transmission distance from north to south was just over 800 miles. The output of the 400 kV transformers was 4,365 MVA and the loading capacity of the system had been considerably increased by using 400 kV series capacitors totalling 310 MVA. Smooth voltage regulation had been obtained by installing 75 MVA hydrogen-cooled synchronous condensers and 1,000 MVA reactors in most of the important receiving stations, while to improve the stability, the generators and transformers had been designed with extra low reactances.

In view of the advances made in constructional technique, particularly in the fields of tunnel blasting and dam building, and the rising fuel costs in steam stations estimates of the potential power in Sweden suitable for exploitation had increased considerably during the past decade. Thus it was now considered feasible to develop 80,000 million kWh per annum, compared with 40,000 million kWh ten years ago and allow from 3,000 to 3,800 MW to be transmitted. The greater part of this additional power would have to be transmitted from the north to the south, a fact which had led to an investigation of the design of the future system.

Although these investigations had not yet been completed certain conclusions could be drawn and these were summarised in the paper. Notwithstanding the large increase in demand the primary transmission voltage would still be based on 400 kV. By installing a third phase-conductor and increasing the series compensation, however, the optimum line loading would be raised to about 800 MW, thus allowing a by no means insignificant reduction in the transmission costs to be effected.

More efficient utilisation of the existing 400 kV line construction would enable the operating voltage to be raised to 500 kV and the construction of installations for this voltage did not appear to offer any serious technical problems. The optimum loading would be increased to about 1,000 MW thus enabling the number of lines to be reduced.

With the present standard of technique, 650 kV was considered to be the highest conceivable transmission voltage. This would give an optimum line loading of not less than 1,700 MW, but the transmission economy would be satisfactory at much lower loads. Comprehensive development work would, however, be necessary and it was doubtful whether the change over would be justified in a country as small as Sweden.

KUIBISHEV-MOSCOW LINE

A paper on the Kuibishev-Moscow 400 kV line and substation was presented by Messrs. A. A. Gogolin, K. K. Levitsky, A. V. Mirolubov, S. S. Rocotjan V. N. Sergejev and B. V. Sokolov (U.S.S.R.) Work was begun in 1952, and the 400 kV south circuit and the east receiving substation in the Noginsk district of the Moscow region were now in operation at the full voltage. The line had been designed to transmit 1,150 MW, the south circuit being 815 km and the north circuit 890 km. long. There were three intermediate switching stations on both lines, the middle one of which was equipped with series capacitors. At Noginsk the south circuit was connected to the east substation in Moscow and the north circuit to the north substation, the two substations being "tied" by a 400 kV line, 77 km. long, which formed part of the Moscow ring system. About half of the route was through forest clearings and several navigable rivers were crossed. On less than 5 per cent. of the route there were swampy areas.

A steel-cased aluminium conductor with an aluminium cross section of 480 sq. mm and a steel cross section of 59·7 sq. mm. has been used, the overall diameter being 30·2 mm. The insulators were of the porcelain suspended type and on the suspension towers a string assembly supported the bundle conductors in a releasing clamp which opened when all three conductors failed. This arrangement had operated well during severe sleet conditions and limited the horizontal tension to 2·5 tons when all three conductors in one phase failed.

The distances between the conductors forming a phase were limited by spacers of the hinged type, the bundle conductors being connected in pairs so that where one failed the others shifted and the spacer released them, thereby protecting the outer strands of the sound conductors from damage. The towers were of welded open-hearth steel with an ultimate strength of 3,900 kg. per sq. cm., those used for suspension having hinged connections between the legs and the cross arms. This construction was economical in material and convenient to erect and maintain. Either metal grids resting on reinforced concrete slabs or packed on mass concrete was used for the foundations.

The sub-stations in the Moscow district, which formed parts of the projected 400 kV ring system were of the double busbar type and were equipped with two step-down transformer banks, one of which was connected to a single 400 kV busbar through an isolating switch, in order to minimise the number of 400 kV circuit-breakers. The transformers were of the three winding type and had secondary voltages of 110 kV and 11 kV with a rating of 90 MVA per phase. To reduce the fault current the 11 kV winding was divided into two and a 75 MVA synchronous condenser was connected to one of them.

The 110 kV output was controlled by regulating transformers with a throughput of 270 MVA, which were installed in the neutral of the 400 kV transformer. All the 400 kV outdoor switchgear had a current rating of 2,000 amperes, the short-circuit capacity during the first stage of the development of the network being about 10,000 MVA. The 110 kV switchgear consisted of two busbars, one of which was connected to one 400 kV and one to one 200 kV transformer and to half the outgoing 110 kV feeders.

The design of the 400 kV equipment installed, all of which was manufactured in the Soviet Union, was discussed in detail in the paper.

A NATIONAL SYSTEM IN AUSTRALIA

A paper describing developments in extra high voltage transmission in Australia was presented by Mr. W. Diesendorf, who pointed out that the growth of electricity consumption in that country had led to the conception of a large 330 kV transmission system to serve the States of New South Wales and Victoria.

In New South Wales modern power stations, located on the coalfields south, west and north of Sydney, were to be built and the question of installing units with outputs up to 120 MW was under consideration. In addition, water power developments were taking place on the Clarence River and in the Snowy Mountains where a series of water power stations would generate 5,830 million kWh per annum.

Because of irregular water flows and the need for large costly storages the base load would be generated in thermal stations. The ultimate firm power of the Snowy Mountains scheme should, however, be about 3,000 MW, of which two-thirds would be supplied to New South Wales and one third to Victoria at 330 kV, the overall transmission distance for the main blocks of power being some 250 miles. The scheme might take 20 to 30 years to complete, a circumstance which would have an important bearing on the choice of voltage.

For many years most of the base load requirements in Victoria had been met from a brown coal fired station at Yallourn. Fields in the Latrobe Valley were now being developed and power would also be obtained at 220 kV from the 300 MW Kiewa hydro-electric scheme, 160 miles

from Melbourne. In South Australia supply was mainly obtained from a coal-fired station at Port Augusta and transmitted at 132 kV over 190 miles to Adelaide. It was proposed to increase the capacity of this station to 330 MW and to raise the transmission voltage to 275 kV, the new lines paralleling the existing 132 kV system.

At the present time there was no prospect that extra high tension voltages would have to be used in either Queensland or Western Australia, while in Tasmania, where the supply was based entirely on water power, the present highest voltage was 110 kV, though some 220 kV lines were under construction.

It was estimated that sufficient water power could be economically developed in Tasmania to meet a yearly average load of 1,300 MW. As this would probably all be required for that State's own use within 30 years it would not be to its interest to export to the mainland as had been suggested, except on a temporary basis. In Eastern New Guinea and Papua there was an estimated exportable water power of 25,000 MW, but as the distance to the Australian mainland was 1,500 miles, including a sea crossing of 100 miles, it was clear that it would not be utilised while other more easily tapped resources were available.

GERMAN PRACTICE

In order to meet the increasing demand for power in Western Germany it was decided in 1949, to begin preliminary work on the construction of a 380 kV interconnected system, it being considered that the existing 220 kV system would be inadequate for transmitting large blocks of power from the Rhine-Ruhr district to the south and south-east and from the Alps to the north. The construction of the lines had now been begun and was described in a paper by Messrs. G. Boll and H. Roser. It was intended to start operations at 380 kV next year.

Dealing with some of the basic problems involved in carrying out this project the authors gave reasons why it was decided to use a solidly earthed neutral point in contradiction to the former German practice of employing arc-suppression coils. Experience with the Peterson coil at 220 kV, both in Germay and Sweden, had shown that the protection it afforded was often illusory. Switching surges were also less severe on a solidly earthed system, the design of the transformers was simplified since graded insulation could be used, and the possibility of connecting the German system with those in other countries had to be considered.

Preliminary calculations showed that short-circuit powers of 8,000 MVA could be expected at certain points on the 380 kV system but that these might rise to double that value later unless special precautions were taken. Impedance relays and graded time relays were envisaged for protection and reactors, connected to the 30 kV tertiary windings of the 380 kV transformers, were proposed to compensate the charging current. To avoid the transmission of reactive power over long distances energy would as far as possible be taken from the 380 kV system at unity power factor. The flow of reactive power would be controlled by regulating the voltage in the 220 kV system and by tap changers on the 380/220 kV transformers. All the 380 kV transformers would be equipped with on-load tap changing gear for the control of the operating voltage and of the interchange of reactive power between the higher and lower voltage systems.

DEVELOPMENTS IN THE UNITED STATES

A report by Messrs. P. Sporn and W. S. Price summarised the initial construction and operating experiences on the 1,162 circuit miles of 330 kV transmission lines which were now in service on the system of the American Gas and Electric Company and the Ohio Valley Electric Corporation, particularly with respect to lightning and corona. It was pointed out that the level of radio interference in the first 330 kV line to be energised was somewhat higher than that had been predicted, a result which was attributed to the corona produced by dirt, abrasions, excess conductor saturant on the conductor surfaces and line hardware.

To improve matters stringing methods were modified so as to keep the conductor off the ground during construction and the amount of conductor saturant was reduced. On the 330 kV double circuit lines, a phase sequence of 1, 2, 3 from top to bottom on both circuits produced an appreciably lower radio interference level than other phase arrangements. These levels had, however, decreased over a period of six to twelve months apparently due to ageing. The outage rates due to lightning had been greater than had been expected, but adverse effects had been prevented by the use of ultra high speed re-closing on the circuit-breakers.

INSULATION AND CORONA

In a special report dealing with the papers in this Group Mr. F. Cahen said that the essential features to be considered from a technical point of view at voltages over 380 kV were the insulation level of the material and the disturbances to radio and communications, due to corona. At 500 kV internal over-voltages had led to insulation levels of 1,600 kV, provided the lengths of section of the line did not exceed 600 km. and the increase to this figure was fully justified.

The use of bundles of three conductors, 31·7 mm. in diameter, and arranged in an equilateral triangle with 45 cm. sides might prove a satisfactory way of eliminating disturbances to radio communications. When the insulation levels were increased to 2,200 kV, four bundle conductors arranged in a square with 40 to 45 cm. sides would have to be used.

The subject of alternators was dealt with in nine papers comments on which were made by Mr. A. Wust in a special report. He pointed out that, owing to the increasing demand for power, larger generators would have to be installed especially in thermal stations. Three papers dealt with new techniques in alternator construction, of which that due to Messrs. W. L. Ringland, L. A. Kilgore and C. E. Kilbourne, dealt with generator cooling in the United States, particularly in connection with very large 3,600 r.p.m. machines.

A paper by Messrs. A. Mandi, Urbanek and L. Heller described the use of a liquid for cooling rotors and pointed out how the basic temperature of the cooling fluid could be reduced by inserting a refrigerator at suitable points in the system. This might be an alternative to raising the gas pressure in hydrogen-cooled machines. The ideal refrigerator, the authors thought, was one using the expansion of steam taken from the turbine.

INSULATION OF LARGE MACHINES

A paper on the insulation of large synchronous machines, by Messrs. J. Fabre, G. Lang, J. Laverlochère, G. Leroy, J. Narcy and G. Ruelle, described test methods for verifying the quality of a winding and its behaviour over a period. This was based on the rise in temperature of the stator copper, measurements being made while the machine was in service. It was stated that this method had now been adopted by Electricité de France and had proved quite satisfactory. Other non-destructive methods were available and Mr. Wust raised the question as to which should be adopted for acceptance tests and for investigating the windings in service.

In a paper on the associated subject of the measurement of temperature rises on alternators during operation, Messrs. E. W. Connon and S. J. Morley showed how important it was to know as accurately as possible the maximum temperature reached by both rotor and stator windings. While the rotor temperature could be judged with fair certainty there was no satisfactory method of ascertaining the temperature reached by the hottest part. In the paper on insulation referred to above, however, it was, pointed out that for an insulating material of known thermal properties, a study of the slot field allowed the temperature of the copper to be ascertained with reasonable accuracy when the temperature indicated by the instruments was known.

TRANSFORMER DESIGN

A number of points affecting the design of transformers were brought forward in 6 papers upon which Mr. R. Langlois-Berthelot reported. Three of these dealt with the subject of tests with chopped waves about which the question was raised whether these were realistic from the standpoint of the user and whether it was appropriate to specify limits for the time interval between the origin of the 1/50 wave and the chopping time, say 3 microseconds.

Three papers by G. B. Harper, S. Glover and C. M. Brownsey, by E. Tobin and by R. J. Ringlee, considered problems of transformer noise, which was becoming of increasing importance as substations were built in the vicinity of residential property. An important point in this connection was to characterise the sound level by a numerical criterion. Agreement appeared to exist on the root-mean-square value of the sound pressure expressed in logarithmic units, referred to at basic level, and corrected so that the classification corresponded to the auditive impression. These measurements were made in a typical location at a given distance at various points round the transformer. A weighted mean was taken and a numerical value obtained which was used for a guarantee on a contractual basis. A table could then be prepared giving the sound level in decibels of the transformer as a function of its voltage and rating (the level was recognised as being proportional to the logarithm of the kilovolt-amperes).

REDUCING NOISE

Mr. Tobin was pessimistic on the subject of reducing noise. This was a manufacturers' problem and nearly all of them had reached the view that nothing much could be done about the magnetic circuit or in the use of resilient supports for the core or sound absorbent barriers within the tank. There was certainly an advantage in reducing the induction density, although this was a costly solution compared with what could be done by installing the transformer so that the sound field was economically controlled and taking the background noise into account. For this purpose Mr. Ringlee suggested the use of scale models with an appropriate reduction in the linear and frequency scale in order to obtain the same sound levels. Tests had shown good correlation between an installation and its reduced scale image so that the best arrangement for attenuation could be found.

SHORT-CIRCUIT FORCES

The problem of short-circuit forces assumed a much greater importance as the short-circuit power of the system increased in relation with the development of high rupturing capacity breakers and the rise in transformer ratings. When a large high tension system was solidly earthed an earth fault was a short-circuit. From the manufacturer's point of view the problem was to pre-determine the mechanical forces on the different parts of the windings, the axial and radial components of the leakage fields where the conductors were located being considered separately as these respectively determined the radial and axial compression forces. The complete calculations of the axial forces were very difficult to make and the problem was complicated when the ampere-turns were not exactly balanced.

The user's problem was whether the cumulative effect of repeated short-circuits, which caused axial displacements and instability, made a single short-circuit test sufficiently representative. Another question was the "withstand" ability of active and inactive materials to the mechanical stresses caused by the radial and axial forces. This was related to the properties of the insulating materials and their depreciation with time, the changes in the elastic qualities of the copper and its crystalline structure as a function of the temperature, the stability of the winding and the distribution of stresses along the turns subjected to unequal forces.

RESIN-CATALYST SPRAY EQUIPMENT

CONTROLLED MIXING OF LACQUER BASES AND GLASS-FIBRE LAMINATES

During the last few years certain organic finishes incorporating resins of the urea-formaldehyde, polyester and epoxy groups have been formulated which, in conjunction with a catalyst, produce a final film which has far tougher and greater wearing qualities than any other material produced in the organic field of finishes.

Apart from the paint field there is also the increasing application of glass-fibre laminates bound together with resins of the polyester group in conjunction with various catalysts.

These catalysts have to be added just before use, since the chemical reaction starts from the time of addition. Up to the present it has been usual to do this operation manually, which is slow and tends to lead to some material waste.

Thus there exists a need for equipment capable of automatically metering the catalyst and resin and of thoroughly mixing them at the moment of atomisation. This need has now been fulfilled by a unit produced by Atlas Copco (Great Britain), Limited, Wembley, Middlesex, known as the Ecco catalyst spray equipment, claimed to be the only one of its type on the market; it will accurately meter the resin and catalyst, thoroughly mix them in their liquid form and finally atomise the mixed resin and catalyst in an even spray pattern.

The Atlas catalyst equipment (Fig. 1) consists of a dosing unit (the D4A), a twin-feed catalyst spray gun (Ecco 30D) with two separate fluid feeds, a standard pressure container for the resins or lacquers and a polythene gravity bucket for the catalyst. (Alternatively, a pressure container can also be used for the catalyst.)

The D4A dosing unit (Fig. 2) consists of three cylinders and pistons, one for catalyst made from solid Teflon, one for air and one for resin or paint. The three cylinders are mounted together at the top on a rigid bar. At the bottom the piston rods are all connected to a connecting rod pivoted at one end, so that they move together.

The catalyst cylinder and piston assembly is adjustable along the top and bottom bars over a distance of approximately 12 in., by means of a lead screw, thus allowing the effective volume of the catalyst cylinder—and hence the ratio of catalyst to resin—to be adjusted relative to the resin cylinder (the stroke of which is fixed) over a range of from 5 to 25 per cent.

The layout of the equipment is depicted in Fig. 3. From the pressure container the resin pipeline runs into the dosing unit through an automatic valve to the inlet side of the resin cylinder, and from the outlet side of the resin cylinder to the normal inlet of the spray gun.

The catalyst line runs from the polythene container to the dosing unit through an automatic valve to the inlet of the catalyst cylinder, and from the cylinder outlet to the rear of the catalyst spray gun. Two automatic cut-off valves in the catalyst and resin circuits are built into the dosing unit.

From the main air supply a high-pressure air line runs from the air transformer direct to the inlet of a hook valve which hangs on the wall of the spray booth. From the outlet of the hook valve the air line travels to the inlet of the dosing unit, is by-passed at full pressure to the two air-operated valves on the catalyst and resin lines, and finally passes to a reducing valve where the main air-line pressure is reduced before entering the under-side of the air cylinder. The main air-line pressure is also carried to the pressure container where it is reduced by a standard air valve according to the materials in use. From the reduced side of the air transformer the normal air line is taken to the spray gun for controlling the atomisation pressure.

OPERATION OF THE SYSTEM

When the hook valve is closed there is no air flow to the dosing unit. Resin from the pressure container is fed by air pressure through the open valve into the resin cylinder, thereby forcing the piston to the lower extremity of its stroke and filling the resin cylinder. As the resin piston travels downwards it carries with it the air piston and the catalyst piston to the bottom of their strokes; catalyst is thus drawn into the catalyst cylinder from the gravity container. This action takes approximately two seconds. The system is now fully charged with catalyst and resin ready for operation.

When the gun is taken off the hook the main air-line pressure is immediately transmitted to the air-operated valves on the catalyst and resin lines, automatically shutting off the supply of resin and catalyst to the dosing unit, and sealing the resin and catalyst charges in their respective cylinders in their predetermined volumetric proportions.

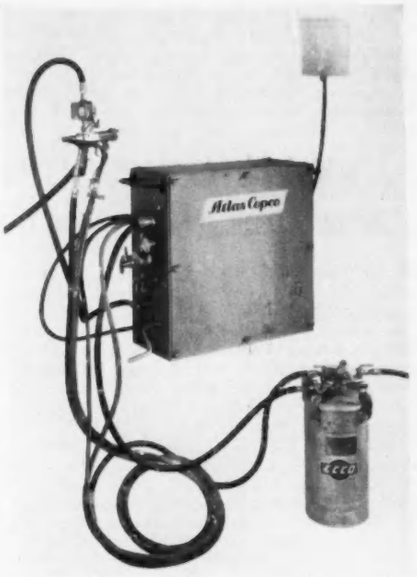


Fig. 1 The Ecco catalyst spray equipment comprises a dosing unit, a twin-feed spray gun, a polythene gravity bucket for the acid catalyst, and a standard pressure container for resin.

At the same time, air pressure reaches the underside of the air-cylinder piston. It is this pressure that acts as a motive power for forcing both the catalyst and resin to the spray gun.

When the gun trigger is pressed, both catalyst and resin are discharged through the spray gun in guaranteed volumetric proportions, irrespective of the diameter or length of hoses between the unit and the gun. As soon as the gun is put up during a momentary break in work the whole system immediately re-charges itself in the same proportions as before.

The spray gun is similar to standard Ecco guns with the exception that it has a hollow needle through which the catalyst flows and a catalyst valve which is fixed to the backhead of the spray gun. When the trigger of the spray gun is pulled, it not only lifts the needle from the seating in the resin nozzle—as in normal spraying—but at the same moment also opens the catalyst valve in the back of the gun, allowing resin and catalyst to flow together. Should the needle be

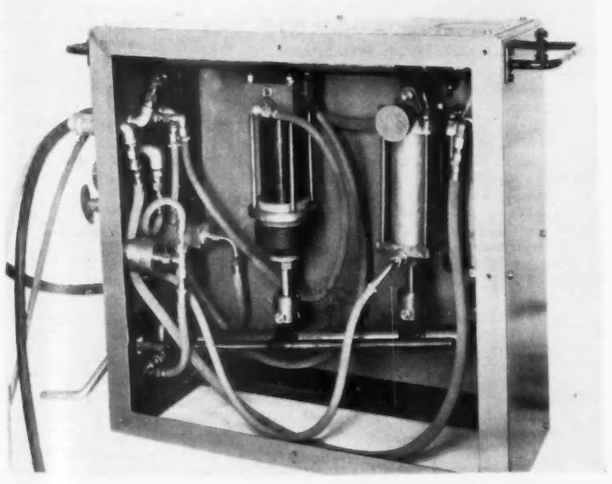


Fig. 2 The dosing unit. The catalyst cylinder seen on the left can be traversed along the lower pivoted connecting rod thus altering its effective volume relative to the fixed resin cylinder (extreme right). The centre cylinder, also fixed, is an air cylinder providing the motive force for charging the spray gun with metered resin and catalyst.

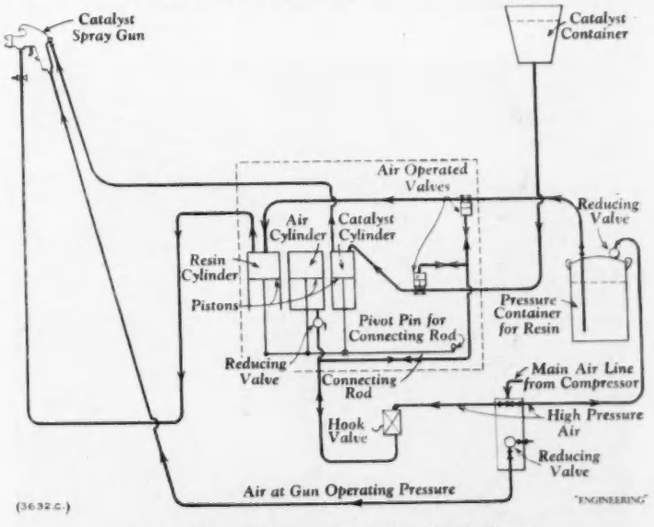


Fig. 3 Layout of the resin, catalyst and air lines.

slightly out of adjustment it is impossible for the resin or catalyst to start flowing one before the other, as they are both under pressure from the same source and the connecting rod cannot start to move until both the catalyst and resin valves are open. The whole machine stops working if there is a blockage or temporary stoppage in either the catalyst or resin supply. The catalyst is carried in the centre of the resin flow and, with atomisation, it cannot fail to be thoroughly mixed with the resin since it is symmetrically aligned with the resin in the air stream.

TRANSONIC-SUPERSONIC TUNNEL

40,000 H.P. TOOL FOR CO-OPERATIVE RESEARCHES

In Southern California, a co-operative subsonic wind tunnel financed by the Douglas, Convair, Lockheed and North American companies—later joined by the McDonnell Aircraft Corporation—has been in use since 1945, operated on a non-profit basis by the California Institute of Technology. Recently the tunnel has been rebuilt and converted to a transonic-supersonic tunnel, with a power increase from 12,000 h.p. to 40,000 h.p. The new tunnel was opened on April 25 by Mr. Charles S. Thomas, Secretary of the U.S. Navy.

The California tunnel is designed for speeds up to Mach 1·8, and the maximum Reynolds number attainable is about 11×10^6 per ft. The maximum wing span which can be accommodated is about 8 ft. The working section is separated from the rest of the tunnel by gate valves which rise from below the tunnel floor. Thus, the test section can be equalised to atmospheric pressure while the rest of the tunnel is left at some other pressure. A minimum amount of time, then, is required for bringing the complete tunnel circuit back to the operating pressure after the working section has been entered to make a change on the model. There are three different working sections which can be rolled into or out of the airlock on steel rails provided on the floor—subsonic, transonic and supersonic. The working sections are 8 ft. 6 in. high by 11 ft. 6 in. wide (the transonic throat being slightly smaller).

The tunnel is driven by four 16 blade fans, one driven from each end of a 20,000 h.p. 600 r.p.m. synchronous motor, of which there are two. The motors are brought up to speed for line synchronisation by a variable-frequency power supply. Regenerative braking provides for a quick slow-down of the air in the tunnel. The pitch of the fan blades, which are of forged aluminium, can be remotely controlled.

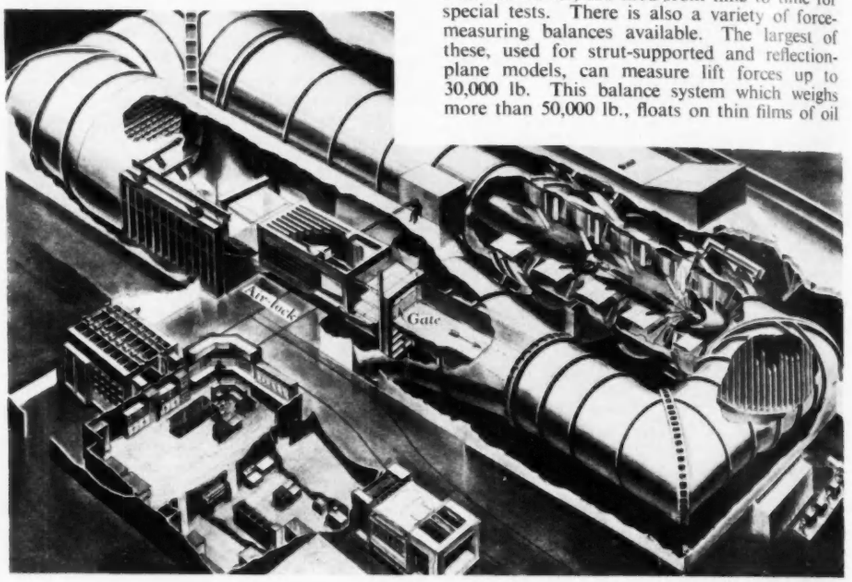
Electricity is brought in from the Pasadena Municipal Power Company through underground cables. Power for the main drive system comes in at 34,000 volts and is stepped down to 6,600 volts at the wind-tunnel substation. Power for the starting set comes to the substation at 17,000 volts and is stepped down to 2,300 volts.

To change the air pressure in the tunnel, which can be operated at pressures between 0·1 atmosphere and 4 atmospheres, a 7,500 cub. ft. per minute Allis Chalmers compressor has been added to the 4,000 cub. ft. per minute Nash compressor which was used for the purpose before the tunnel modification.

The tunnel is water-cooled by two copper-fin radiators capable of removing 1,700,000 B.Th.U. per minute from the air. The cooling water, circulating at 10,600 gallons per minute, is cooled in two cooling towers.

For removing moisture from the tunnel air, a system combining cooling with liquid adsorption is used. There are four stages of finned-tube heat exchangers which are contained in a single pressure vessel. The air-water-vapour mixture is cooled with ammonia to 40 deg. F. in the first two stages, and then is cooled to as low as − 17 deg. F. in the third and fourth stages. A lithium-chloride solution is sprayed over the coils of the last two stages, acting both as an anti-freeze and a liquid desiccant. The lithium-chloride solution is continuously circulated through a still to remove the water.

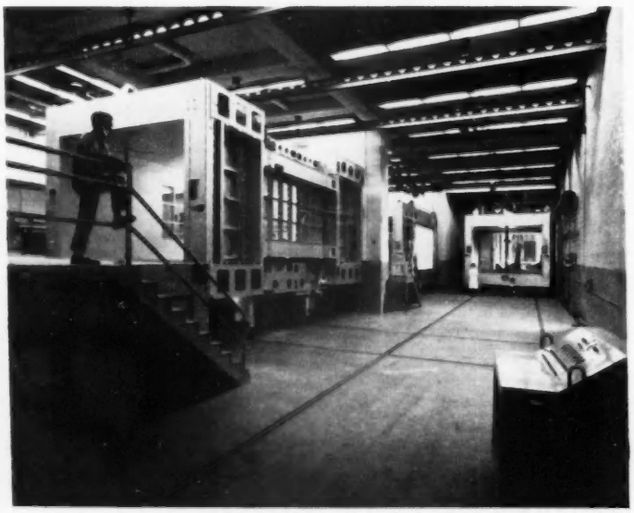
For supporting the test models, a variety of systems is available including swept struts (single and three-point), three-point straight struts, sting supports, and reflection-plane mounts for half-span models. Other types of supports, such as stranded cables, are used from time to time for special tests. There is also a variety of force-measuring balances available. The largest of these, used for strut-supported and reflection-plane models, can measure lift forces up to 30,000 lb. This balance system which weighs more than 50,000 lb., floats on thin films of oil and measures forces of a fraction of a pound by means of hydraulic capsules and precision gauges. For sting-mounted models, electrical strain-gauge units are employed, mounted within the model.



The Southern California wind tunnel at the California Institute of Technology operates at speeds from subsonic to Mach 1·8. It is powered by four 16 blade fans driven by two 20,000 h.p. motors.

Other types of observations carried out in the tunnel include pressure recordings at various points on the model or tunnel, shadowgraph pictures for determining shock patterns produced by the model or the support devices, tuft pictures to determine flow direction on aerodynamic surfaces, dynamic force or pressure recording to measure buffeting, and a Schlieren system to study shock patterns, determine Mach numbers at various places in the test section and over the model, etc.

Practically all of the data are recorded automatically on an IBM punched card system and a tabular data sheet. An electronic computing centre adjacent to the control room makes it possible to reduce the data to a form which can be applied to the final aeroplane in a few seconds.



The working section of the tunnel is removable on rails and three different sections are provided for the subsonic, transonic and supersonic ranges.

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MORE BRITANNIAS FOR R.A.F.

The Ministry of Supply has ordered four more Bristol Britannias for Transport Command. This brings the total on order for the Royal Air Force to 10 aircraft; in addition there are three 250 Series aircraft on order by the Government for trooping work.

The aircraft are Series 250 Britannias, a "mixed" version designed to carry both passengers and freight. The Series 250 has a body longer than that of the initial production version and is fitted with the more powerful Proteus 755 propeller turbine of 4,120 equivalent horse-power. It will carry between 110 and 120 troops, or 30,000 lb. of freight, over 3,000 miles non-stop.

A total of 55 Britannias has now been ordered. Nine production aircraft have flown and five of the 33 on order for B.O.A.C. have been delivered.

Institution of Naval Architects Spring Meeting (*continued from page* 493)

PLATE AND PROPELLER EXPERIMENTS

Two papers were presented at the morning session of the Institution of Naval Architects on March 22, these being on "The Brittle Fracture Strength of Welded Steel Plates," by Dr. A. A. Wells, and on "Contra-Rotating Propellers," by Dr. J. D. van Manen and Dipl. Ing. A. Sentic. For the first of these the chair was taken by Sir Charles Lillicrap, K.C.B., M.B.E., D.Sc., and for the second by Professor A. M. Robb.

BRITTLE FRACTURE STRENGTH OF WELDED STEEL PLATES

Dr. Wells's paper described the results of a series of tensile tests on 1 in. mild-steel plates containing central notched butt-welds parallel to the direction of pull. The notches consisted of fine shallow saw-cuts made in the plate edges prepared for welding and were intended to simulate weld flaws, as it had been established that more than half of the serious failures in American oil tankers resulted from butt-welds of poor quality. The tests were conducted within a temperature range of +15 deg. C. At temperatures above 4 deg. C., the plates sustained average static tensile stresses up to the yield point before brittle fracture occurred. Below that temperature, brittle fractures across the residual stress zones of the weld started from the saw-cuts, either spontaneously after welding or with small external loads. With continued loading, complete fractures were obtained only after a general yielding of the remaining cross-sections of the plates. At 4 deg. C., a single stage fracture was produced at half the yield-point stress. Considerable importance was attached to that critical temperature, at which alone a complete fracture could be obtained at that stress; in further tests between +15 deg. C., no fractures could be produced in the residual stress zone at less than yield-point stresses in welded plates which had been previously stress-relieved by stretching at 40 deg. C. The author presented evidence indicating that the behaviour in the tests described might be explained mainly in terms of the mechanical effects of weld shrinkage and residual stresses, and metallurgical damage over the narrow weld-hardened zone.

Dr. R. Weck, who opened the discussion, referred to the author's statement that "The peak tensile stress of 23·5 tons per sq. in. along the weld is indicative of metallurgical effects other than simple shrinkage during the cooling cycle," and wished that he had explained what he thought those metallurgical effects might be. Was it not possible that such metallurgical effects might be superimposed on the effects of residual stresses and that they might have an equally serious effect on the initiation of brittle fracture? The strain energy for the propagation of a crack had been measured by the author, for the plate material, by a series of notched bend tests of decreasing size, and it was important to know whether that energy absorption was the same for the weld material and for the material in the affected zone. A further important aspect was that, after overloading or prestraining, it was possible to relieve the residual stresses and thus prevent the initiation of the short fractures which propagated under relatively low external loads.

He would have thought that, if a notched plate were extended at above the transition temperature at a stress equal to, or at about, the yield point, and then unloaded, there would be residual compressive stresses at the end of the notch on unloading; and that it was a consequence of those residual compressive stresses that fracture did not commence at a low stress when the stress was repeated at below the transition temperature. That would not necessarily apply, however, under all circumstances; another aspect which might well be investigated further. Was not too much emphasis placed on the role of residual stresses? It was concluded, in the paper, that the residual stresses themselves were responsible for supporting propagation of the primary fractures, so that, without them, low-load fractures of the "calamity" kind were not possible in tests of the type described. The author stated that: "This conclusion cannot, however, be lifted from its context and applied to all structural conditions, since some exist where there are high strain energy release rates at quite low stress levels . . . ." That sentence needed to be printed in bold type, because it was extremely important, and he hoped the author would enlarge on it, particularly in regard to fractures in ships.

Mr. J. Hodgson said that, during recent years, Lloyd's Register had investigated numerous cases of fractures in welded ships. Most of those examined in detail were in ships built since the war and, in many of them, the lessons learned from the early American ship failures had been applied. From a study of the service history of those cases, it could be postulated that, from an initial defect, a small primary natural crack developed and extended into the parent plate. The time in which that occurred might be long or short; it might even be several years, depending apparently on the fluctuating cycles of stress, temperature and weather, in relation to the quality of the steel. The component stages in serious fracture were demonstrated in Dr. Wells's test, and he appeared to have classified them correctly. Casualty results showed that serious fractures had occurred without previous warning in many ships after long periods, despite the fact that the ships had been for some years in the same service, encountering weather or temperatures equal to, or probably worse than, those which attended the casualties. Moreover, extensive and serious fractures had occurred at sea at service temperatures from about minus 5 deg. to plus 20 deg. C. He had wondered sometimes whether there was some factor of time endurance applicable to the steel. He did not call it "fatigue" because symptoms of fatigue were never present in the material when examined. There was also the possibility of strain-ageing of the material over varying periods of time.

SHOCK AS A SERVICE FACTOR

Another very important service factor which emerged from many investigations was shock. In three recent cases of the complete failure of post-war ships, shock had been definitely reported. An extract from the log book of one of the ships stated that there was a gale with wind force 8 to 9, sea and swell heavy, and occasional seas coming on board. The ship took two seas over the forecastle, which gave shocks; a few minutes later another shook the ship very badly, and a sharp sound was heard at the midship deckhouse; that was that. The ship was eight years old and she broke in two towards the end of a north Atlantic voyage in winter. The temperature was 0 deg. to 4 deg. C. During her eight years, she had been on precisely the same run, carrying precisely the same types of cargo. From the evidence of the captain and officers, the fracture started in a weld. He wondered whether the results of the investigation described in the paper would have been the same, if the strain rate had been varied, or if the test pieces had been given a blow with a hammer when at a very low stress, or if some time factor had been introduced into the experiments.

He thought that the paper marked the start of a very important investigation, but, after reviewing the circumstances of many casualties, he did not think it told much about the paramount question of how tough a plate should be to meet service conditions successfully over a long period. Such an investigation should be based on a realistic appreciation of service conditions and the significant factors or characteristics which emerged from many failures, and correlation with service behaviour was necessary if such experiments were to be used as a guide.

With regard to the author's remarks on the correlation between the Charpy energy transition and the designated calamity temperature, Mr. Hodgson mentioned that, from analyses of many tests on casualty steels, they had been unable to find any common reliable datum on a Charpy energy curve which would correlate with service fractures for all steels. Instead they had found a very promising correlation between fracture appearance and service casualties, inasmuch as a casualty material subjected to different forms of tests exhibited, at the casualty temperature, a predominantly or wholly crystalline fracture. In other words, it manifestly showed itself to be brittle.

It might be inferred from the paper that, provided the seams in a welded ship were stress relieved, a fairly brittle steel could be used. Any such proposal, in his opinion, would be absolutely wrong. The extent to which stress relieving, if practicable, would contribute to the safety of a ship was a very open and doubtful question.

The paper stated: "It has been established generally that welds of good quality do not act as brittle crack initiators even when the base material is appreciably below its transition temperature." Presumably, by "good weld" the author meant one entirely free from incipient cracks, flaws or other defects, because, under service conditions, there must always be potential sources of fracture initiation from a small defect in a weld. No shipbuilder could guarantee the complete absence of weld defects or incipient weld cracks; and it was as well to remember that, similarly, steelmakers could not guarantee their steel to be entirely free from minor inclusions or small internal defects, which might be potential sources of fracture.

Dr. L. Reeve said that there was no doubt of the importance of the initial weld defect which, in some cases, developed into an initial weld crack; and the author had clearly indicated the significance of internal stressing, under certain conditions of loading, in spreading that initial crack into a primary crack. In the case described, the initial defect was a saw cut 2 mm. deep. He suggested that work should be done on lengthening the saw cut to make it 3 or 5 mm. or even more, to determine the relationship between the size of the initial defect and the mechanism of the primary cracking.

Mr. R. H. Richards, said that the paper had been studied with great interest at the Naval Construction Research Establishment, where research work on brittle fracture had been in progress for many years. Much of the work done at the Establishment could not be published for reasons of security, but some work which had a direct bearing on the paper was carried out a few years ago in the Welding Laboratory there and was published in the *Transactions* of the Institute of Welding for October, 1953. He was surprised that it was not mentioned in the paper.

It was not easy to follow some of the author's energy arguments, for there were several experimental and theoretical steps which lead finally to his Fig. 13; in some cases, those steps were based on measurements with artificial cracks statically opened. In contrast, crack-stopping experiments at the Welding Laboratory suggested that Dr. Wells's results might be interpreted more simply in relation to stress levels. It was stated in the paper that, in tests on other steels, the author had obtained five other "calamity" specimens. It would have been interesting to have had more information about them and also on the more definite results, not quoted in the paper, which Dr. Wells had obtained on another mild steel.

SHARP CRACKS AND BLUNT NOTCHES

Dr. L. E. Benson, while appreciating the value of the paper, criticised it for not going farther in interpreting the data it provided. He did not believe that 4 deg. C. was in any scientific sense a critical temperature, and he deplored the term "calamity temperature." Fig. 8 demonstrated Dr. Wells's main point but it was not the best way to show what was really happening. Something might be done, however, by making use of the residual stress distribution shown in Fig. 10, to estimate the total stresses operating at the start and finish of the cracks. It was necessary to differentiate between cracks developing at pre-existing sharp cracks, and cracks starting at machined notches, which were comparatively blunt. Using only data given in the paper, a diagram could be constructed, having at the bottom the terminal stresses for the primary cracks, to indicate the approximate position of the curve of minimum stress needed to maintain a running crack. If Dr. Wells knew the temperatures at which cracks occurred on cooling down, the right-hand end of the curve could be checked. The points plotted in the top half of his graph gave curves for the stress to initiate cracks versus temperature. Two curves had to be drawn, the lower one for cracks starting at cracks and the top one for cracks starting at relatively blunt machined notches. The Tipper tests—brittle fractures starting at machined notches—fitted well into the picture and he suggested that their inclusion was justified.

The point H in Fig. 8 was unique, Dr. Benson continued, because it was the only secondary, or complete, fracture to start at a saw cut. Had more specimens been pulled at higher temperatures, those with cracks starting from saw cuts would have given secondary failures at the same level of applied stress as fracture H—about 9 tons per sq. in. Those with primary cracks would have continued to fail at about 15 tons per sq. in., and there might have been some between, giving a band of points to the right of 4 deg. C. To the left of that temperature, saw cuts gave rise to cracks at lower applied stresses, so that the cracks were arrested on running into the low residual-stress field and became primary cracks. Below the —1 to 4 deg. C. transition, therefore, there remained secondary cracks starting only from primary cracks, the applied stress being relatively high because the residual stress there was low and because a primary crack, once stopped, required a stress in the region of the yield point to start it again. The surprising result was that, under certain conditions, the applied stress for catastrophic failure could be lower at temperatures above the "transition" temperature than at temperatures below it. The important question arose, was there or was there not a notch sharpness factor for the initiation of brittle cracks? Again, more experimental work was wanted to provide real information. There was, of course, no question about there being a notch

sharpness effect at temperatures where the fracture changed in character from brittle to tough. He was grateful for the convincing answer that the paper provided to those who had asserted which residual stresses did not matter in connection with brittle failure. Of course they mattered: they were often a vital factor.

Mr. T. S. Robertson asked for some reliable references to the work on the stress picture ahead of the crack. A lot of work was going on in America on measuring with strain gauges the stress field ahead of the apparent crack on the surface, but it was becoming more and more evident that the crack tunnelled under the surface a long way ahead of the appearance either of yield stress or of the break of surface. There had been investigations on transparent plastics also, to study the progress of the actual crack and to measure stress fields. It was extremely difficult to get reliable indications of where a crack had reached at a given time, though he and others were working hard on the problem. There was a general tendency to regard the brittleness of a material as constant. What was the effect of roll strain on the material? He believed it was brittleness, and that the condition of the material changed adjacent to the notch; so that a crack, once started, might stop as the result of running into a less cold-working zone, in which the transition temperature was lower.

Mr. W. D. Rankin thought that the concept of a "calamity" temperature was novel, but one which required further investigation to substantiate its relation to service behaviour. Generally, in the case of ships or other welded structures which had failed, the drop in temperature so often associated with casualties occurred while the structure was under its working stress, which might not be static, but fluctuating considerably. In the Wells test, the sequence of applying the load and cooling was reversed in relation to that occurring in most service casualties. It remained to be seen whether there was a difference in the results obtained by cooling before applying the load and in those obtained in applying the stress before cooling. Work was in progress to see whether the service behaviour occurring in structures such as ships at sea, in heavy weather and low temperatures, could be simulated in the laboratory. The idea of a limiting stress at any given temperature, below which propagation would not occur, was supported by Dr. Wells' mathematical analysis.

RE-STARTING CRACKS

Dr. S. Livingston Smith, C.B.E., said that the most important result in the paper appeared to be that, after primary cracks had been stopped, it was necessary to go up to the yield stress of the remaining material to make them start again. That had been proved by others and might be taken as an established fact, and it would appear to justify the idea and the policy of having crack arresters. Like previous speakers, Dr. Livingston Smith criticised the "calamity" temperature, but noted with satisfaction that Dr. Wells apparently confirmed what had always been his own belief, that residual stresses must matter.

Mr. J. M. Murray, M.B.E., referred to the statement that the strain-energy release rates for cracks passing through the residual stress zones were measured by means of thermocouples, in accordance with a method described by Dr. Wells to the North East Coast Institution in 1955. Reference to that N.E.C.I. paper showed that it was the surface energy which was measured by the method indicated, and that the surface energy was stated to be generally equal to the released elastic energy. From the present paper, it appeared that the measurements were taken to confirm the run of the strain-energy release curves. Some clarification of that was necessary.

Mr. C. E. Sherwin thought it likely that, in a ship's structure, there must be hundreds of crack-starting devices, perhaps not so pronounced in character as the one used in Dr. Wells's experiments, which if the stress were raised a little higher than for some of those which gave primary cracks, would give a stress high enough to allow the crack to progress much longer than was shown; in fact it could be a catastrophic crack. On the other hand, it was necessary to assume, on the basis of those experiments, that there was a unique "calamity" temperature. He did not think that was borne out by practice, and it should not be read into the results.

Mr. G. M. Boyd emphasised that the tests were made at below the transition temperatures; and that Dr. Wells had said: "it follows that no brittle cracks, primary or otherwise, would be obtained at temperatures above the fracture appearance transition, which may be regarded as the Tipper value of 25 deg. C. for the specimens described in this report." That was important. Did Dr. Wells think that the evidence he had produced substantiated it, or could he substantiate it from other observations? Regarding residual stresses: it could be concluded from the paper that the findings of the Admiralty Ship Welding Committee and of the American Committee were being contradicted. That was not so; those findings were to the effect that residual stresses had no damaging effect on the structure if the material was in a ductile condition, a very important proviso which was not fulfilled in Dr. Wells's experiments.

Dr. Wells, in a brief reply, said that, when the tests were first mooted, the effort was put into the examination of the mechanics of fracture. While it was realised that transition temperatures and characteristics of steel were extremely important, the tests were intended to look into the mechanics; they did not really hope to make any impact on the transition temperature story. It was incidental that the features of critical temperatures emerged. Arising from that, they started with the view that they might get the results with 12 specimens. By the time that these had been tested, it was realised that the temperatures which were of interest had not been wholly covered. So there emerged the additional work on fresh steel, which would be reported as soon as it could be done. There is a note of levity in the term "calamity temperature." It should have been taken out of the paper and "critical temperature" substituted.

CONTRA-ROTATING PROPELLERS

As previously stated, Professor A. M. Robb, D.Sc., took the chair for the latter part of the morning session on March 22, when a paper on "Contra-Rotating Propellers" was presented by Dr. J. D. van Manen (Holland) and Dipl.Ing. A. Sentic (Jugoslavia).

Though their possibilities were indicated by John Ericsson so long ago as 1839, contra-rotating propellers, on the same axis, have found little application except for torpedoes; but it was known that, when placed behind a hull, they showed considerable improvement in efficiency, as compared with ordinary ship's propellers, and the Netherlands Ship Model Basin therefore undertook an examination of their performance, using systematically varied models of the B3-65 type. The screws tested were three-bladed, the front propeller being right-handed and the rear one left-handed. From the results of the experiments, it was found possible to derive a satisfactory survey of the efficiencies, and to obtain data concerning the optimum diameters and the pitch ratios of the front and rear propellers. When analysed with the aid of the circulation theory, the experiments showed that, with a distance equal to 0·37 of the diameter between the front and rear propellers, the axial induced velocity generated by the rear propeller was, as measured at the front propeller, about 30 per cent. of the value obtained infinitely far downstream of the rear propeller. Finally, a method for the rapid design of such propellers was evolved, based on the circulation theory.

The discussion was opened by Mr. L. G. Stevens, who commented on "the manageable way" in which the authors had dealt with the problem of designing contra-rotating propellers. There were so many factors of action and interaction between two propellers that effective design would appear to be extremely difficult, but, apparently, by applying the circulation theory, it was possible to arrive at a reasonably good design fairly quickly. He wondered, however, whether that would always be the case. In comparing the efficiency of contra-rotating propellers with the ordinary twin-screw arrangement, it was necessary to take into account a much larger shaft and boss, and he inquired to what extent that might come in as a factor against the comparison. The authors recommended a test in the cavitation tunnel; what had they in mind in making that recommendation? It was interesting and profitable to test any propeller in the cavitation tunnel but the interaction between fore and aft propellers might introduce some additional likelihood of cavitation. He would hesitate to adopt a contra-rotating system if the interaction were likely to cause cavitation.

Mr. A. Silverleaf considered that the paper had several particular virtues. It was the clearest account yet published of contra-action in a propeller system; it gave the first experimental results published and it presented the first straightforward design method to deal with such propellers. The authors pointed out the limitations of their experimental results and it seemed that the trends were clearly defined by those limited results. A good deal of work was necessary in further experiments to see how closely those trends were confirmed when the range was extended, but the paper gave a lot of sound data. There were, he suggested, two reasons for studying contra-rotating propellers. First, the subject was one of general scientific and technical interest, which in itself was probably sufficient justification for the work. Secondly, it had some considerable practical value. Two obvious practical applications were in respect of torpedoes and for naval craft of specialised types. He would be a bold man who proposed their adoption in the foreseeable future for normal merchant vessels, particularly of the twin-screw type, but there might be a number of cases where contra-rotating propellers could be used with advantage on certain specialised types of vessels. A practical problem was that engine powers would increase in the future, but propeller diameters would not. Diameters were fixed by ship requirements, and harbours and shallow waters would not become miraculously deeper. There were projects whereby, for example, the Harwich-Hook of Holland trip might be transformed from an all-night service to one hour or so; a speed of 60 knots was not out of the question. He did not regard the difficulties of propulsion as insuperable. It would not be a matter of replacing the single screw by a contra pair, but possibly by replacing existing twin screws by contra twins; then they would be concerned with problems such as cavitation breakdown, and with smooth running of the propellers. In those aspects, the ideas which the paper put forward might be developed. He did not think that contra-rotating propellers, if adopted, would necessary follow the form that the paper might suggest; but the paper was by no means a mere academic exercise. Could the authors cite any practical examples of propellers, designed by their methods, being used?

THE GOLDSTEIN OR PRANDTL FACTOR

Dr. J. F. Leathard, discussing the theory of the calculation method, which the authors adopted, mentioned their reference to the interference factor which he believed to be the normal Goldstein or Prandtl factor. He had always understood, he said, that the Goldstein or Prandtl factor governed the type of blade which shed a series of vortex sheets from the root outwards, and this would influence the general distribution of velocities in the wake; there was a spilling-over towards the centre of the blade, over the tip, and round into the next gap. The spilling effect introduced the conception which came from the Goldstein or Prandtl factor. If another propeller was put in, he was not sure what would be its influence on that interference factor. Had the authors actually used the Goldstein factor as calculated for a single propeller, or had they corrected it to take account of the additional interference effect on the wake? That would apply primarily, of course, to the front propeller, and not to the rear propeller. Often, he thought, the thrust could be improved by using a larger propeller. In some cases, the propeller diameter could be reduced if two contra-propellers were used for the same thrust, but there would be difficulties in designing machinery to suit, and there might be a loss of machinery efficiency offsetting the improved propulsion efficiency.

Professor E. V. Telfer recalled how keen the late General G. Rota was in exploring the possibilities of contra-rotating propellers. The bibliography at the end of the paper might be extended to include a paper by Col. F. Rotundi, read before the Institution in 1934, in which full details of the training ship Cristoforo Colombo were given. That was a two-bladed application, but it was claimed that no less an improvement than 20 per cent. over the efficiency of the ordinary propeller was obtained. It was that type of figure which spurred General Rota to further investigations. There was progress still to be made with contra-rotating propellers, and he hoped that not only the Tanks, but also the British Shipbuilding Research Association, might look into the problem. The present paper was not the first, however, to give experimental data on contra-rotating propellers; a very fine investigation by Schaffran was published about 1925. He was interested in airscrews, and tried propellers of airscrew type in water. That work should also be included in the bibliography.

Dr. van Manen, in reply to Mr. Stevens, said that he and Mr. Sentic had checked their method of design by two experiments. They had needed only a small correction in pitch, which was not too big as compared with the pitch corrections for normally-designed propellers. They had compared the effective pitch calculation with the results of their systematic tests and had obtained a good comparison. The shortcomings of the theory were coming out. He was not expert enough to say anything about the mechanical losses. If they developed their work on the hydrodynamic problems of contra-rotating propellers, he hoped to apply the advantages of those propellers to the propulsion of single-screw ships.

With regard to the rotational losses introduced by the rudder, to which reference was made, there was a diagram in the paper dealing with rotational and axial losses for a single screw of optimum diameter in terms of pitch ratio. In many cases, it was thought that a rudder could greatly improve the total efficiency of a ship, but the diagram showed that the biggest gain from the rudder was not more than 4 per cent., even if the rudder had no resistance or no axial loss.

The report of the meeting will be continued.

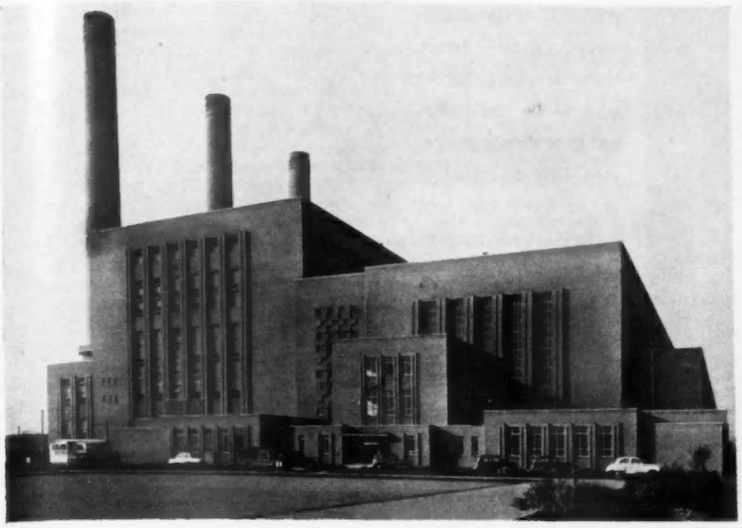

Fig. 1 360 MW power station at Keadby, Lincolnshire. It is a steel-framed building with a concrete-brick cladding.

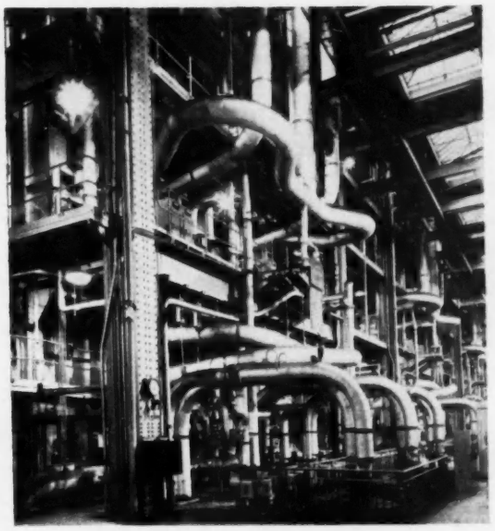

Fig. 2 The boiler house, with one of the 550,000 lb. boilers which is operated on the unit system.

360 MW POWER STATION AT KEADBY

UNIT SYSTEM IN FULL OPERATION

Construction of the 360 MW power station of the Central Electricity Authority at Keadby in North Lincolnshire was begun in 1948, and the first 60 MW set was brought into service in April, 1952. Since then five more sets of like capacity have been added, the last being commissioned in December, 1955. The station was, however, not formally inaugurated until April 20, when Sir Henry Self performed the opening ceremony. This procedure has much to commend it, since it enables the plant to be inspected in its final state and some idea of its operation to be gained.

The constructional work has been carried out under the supervision of Mr. V. A. Pask, chief engineer of the Central Electricity Authority, in conjunction with Ewbank and Partners, Sir William Halcrow and Partners, and Farmer and Dark. The controller of the Yorkshire Division of the Authority, in which Keadby is situated, is Mr. G. A. Vowles, the chief generation engineer (construction) is Mr. W. H. Dunkley and the station superintendent, Mr. W. J. Prior.

The station, which occupies a total area of 181 acres, is situated on the River Trent about nine miles upstream of its emergence into the Humber. To support the buildings about 4,900 piles of an average length of 50 ft. were driven into the underlying Keuper marl and are used to support a reinforced-concrete base slab. The main boiler and turbine house building, which is 470 ft. long by 410 ft. wide, is a steel frame structure with a concrete-brick cladding. The turbine house walls are tiled to a height of 8 ft., above which there are panels of hardboard covered with layers of glass wool, linen and perforated anodised-aluminium sheet to reduce noise. For the same reason acoustic tiling has been installed on the roof of the turbine house and the adjoining bays. There is no division wall between the turbine and boiler houses. An exterior view of the station is given in Fig. 1.

COAL SUPPLY ARRANGEMENTS

Coal is delivered to the station both by rail and road. The rail-borne coal is dealt with in sidings, which are divided into full and empty sections and together can accommodate 650 wagons. Full wagons are discharged into four tipplers with a total discharge rate of 500 tons per hour and the coal is then taken by a twin conveyor system to the boiler house bunkers, coal too big to be handled by the pulverisers being diverted to crushers and then returned to the main system. Alternatively, the rail-borne coal can be discharged on to the storage ground where the road-borne coal is also deposited. Reclamation from the store is effected by three 95 h.p. Diesel-engine tractor bulldozers, which discharge into a hopper connected to the main conveyor system.

STEAM RAISING PLANT

Coal is drawn from the boiler-house bunkers into pulverisers, of which there are four for each of the six boilers, the individual maximum capacities being 99 tons per hour with 8 per cent. moisture in the coal. Three pulverisers are normally sufficient to meet the full-load requirements.

Each of the boilers, one of which is illustrated in Fig. 2, has a continuous maximum rating of 550,000 lb. of steam per hour at a pressure of 925 lb. per sq. in. and a temperature of 915 deg. F., the combustion chamber surface being 16,330 sq. ft. in the case of the first five boilers and 20,350 sq. ft. in the case of the sixth. They are of the radiant suspended type with a single fusion-welded drum (5 ft. 6 in. in internal diameter, 45 ft. long and $3\frac{7}{8}$ in. thick), which is placed 91 ft. above basement level. This drum, as well as the whole of the furnace and the superheater and economiser sections, hangs from steelwork, the top level of which is 108 ft. 6 in. above the basement level. The furnace-ash hoppers are supported from the ground at a basement level and provision is made to allow for the downward expansion of the boiler while maintaining a seal to prevent the ingress of air between the casing and the ash hoppers.

The boiler furnace is completely water cooled with closely packed 3 in. tubes, the arrangement being such that in effect it conprises two furnaces side by side with a central vertical wall of tubes between them. Each half furnace has its own ash hopper. The eight burners are located in the roof of the furnace so that the flame path is vertically downwards. The products of combustion leave the furnace near the bottom

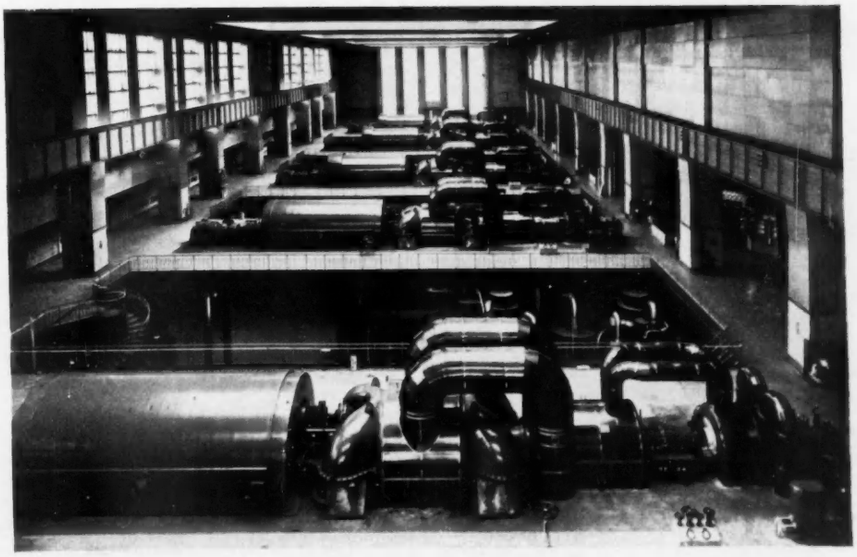

Fig. 3 The turbine room with one of the 60 MW turbo-alternators and its condenser.

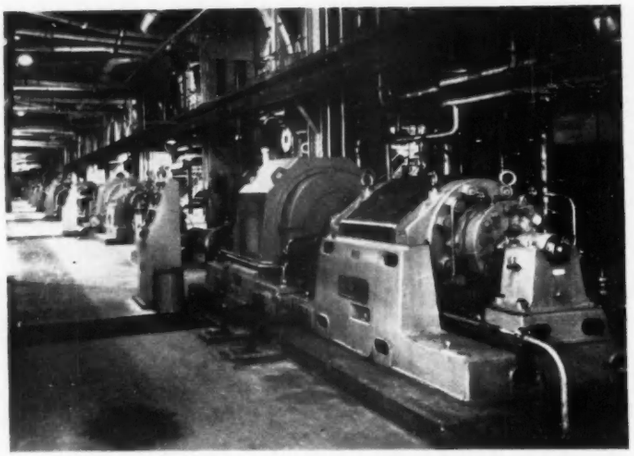

Fig. 4 Circulating-water pump house. There is one pump for each of the six boilers and three standby pumps; each discharges 650,000 lb. of water per hour against a back pressure of 1,225 lb. per sq. in.

and turn upwards over the superheater and economiser tube banks. They then pass through centrifugal separators and electrostatic precipitators into a 325 ft. chimney, one of which serves a pair of boilers.

The superheater is in two sections with a total heating surface of 19,550 sq. ft. in the case of the first five boilers and 22,090 sq. ft. for the sixth. The sections are connected through an attemperator of the spray type for controlling the steam temperature. The economiser is in three sections with a total heating surface of 27,680 sq. ft. in the case of the first five boilers and of 27,800 sq. ft. in the case of the sixth. One of these sections is located in the ducting at the boiler gas outlet, except on No. 6 boiler where all three banks are in the economiser pass.

The boilers are also equipped with two regenerative air heaters of the Ljungstrom type with a heating surface of 142,200 sq. ft., while draught is provided by two induced and two forced-draught fans with individual outputs of 146,500 cub. ft. and 89,500 cub. ft. of air per min., respectively.

The boilers are equipped with an automatic system which controls both the final steam pressure and the final steam temperature. Any variation in steam pressure is converted by a master controller to a pneumatic signal, which varies the rate of fuel supply and flow through the fans. The supply through the induced draught fans is also controlled by a furnace pressure regulator. Variation in the steam temperature is converted by a controller to a pneumatic signal, which controls the valve through which the attemperator spray water is supplied. This is also adjusted by an out-of-balance pneumatic signal which is obtained by measuring the combustion air and spray water flows.

GENERATING PLANT

The generating plant consists of six 60 MW turbo-alternators, which produce three-phase current at 11·8 kV when running at 3,000 r.p.m. The turbine is a three-cylinder reaction type machine with a double-flow low-pressure cylinder, which exhausts into a single shell two-pass condenser with a cooling surface of 60,000 sq. ft. The alternators are hydrogen-cooled and drive the main and pilot exciters through gearing at a speed of 1,000 r.p.m. A view of one of these sets with its condenser appears in Fig. 3.

As operation is on the unit system there is only one control board for each boiler and turbine, on which all the necessary indications and controls are mounted. This board is arranged in three sections, that on the left hand accommodating equipment associated with the turbo-alternator and the middle and right hand sections that for the boiler.

COOLING WATER ARRANGEMENTS

The necessary cooling water is drawn from the River Trent through six intakes in the west bank and then through screens by the same number of electrically driven vertical pumps, each of which can handle 2·7 million gallons of water per hour. These pumps deliver through three 72 in. bitumen-lined steel pipes to the condensers and thence back to the river at a point about 2,000 ft. downstream of the intakes. The pumps have been arranged to ensure that they are always below river water level, the tidal range at this point being 19½ ft.

The condensate is returned to the boilers through five stages of feed heating, there being one pump for each unit with a standby for each pair. All the pumps, which are shown in Fig. 4, are electrically driven by 1,435 h.p. 3·3 kV motors and are designed to discharge 650,000 lb. of water per hour against a pressure of 1,225 lb. per sq. in. The final water temperature at the economiser outlet is 385 deg. F.

The boiler make-up water is also taken from the river and, owing to the fact that it is heavily charged with suspended silt and mud, is first fed into two pre-sedimentation tanks and then treated in an Aitken type sedimentation tank with suitable coagulation materials. It is next passed through sand and anthracite filters and then pumped to storage tanks, from which it is supplied to a blended base-exchange water-softening plant and finally to the evaporators. As the salt content of the river water may reach 30 per cent. there are times when the water softening plant may have to be shut down as it cannot operate efficiently under these conditions. Four 25,000 gallon storage tanks and one 250,000 gallon tank have therefore been installed to tide over these periods.

ELECTRICAL EQUIPMENT

Each alternator is solidly connected to a transformer of the forced-oil water-cooled type, which steps the voltage up to 132 kV. The transformers of the first three sets are rated at 75 MVA and of the other three sets at 72 MVA, the latter being the new standard rating for this size of turbo-alternator. Each transformer is fitted with on-load tap changing gear. The transformer secondaries are controlled from an open-air switching station which is illustrated in Fig. 5 and accommodates air-blast circuit-breakers with a rupturing capacity of 2,500 MVA for the six generator feeders, two station transformer feeders and eight outgoing feeders, in addition to circuit breakers for the bus section, bus coupler and reactors. This switchgear as well as some of the 3·3 kV gear is operated from a control room in which the panels are arranged in a circle.

Auxiliaries supplies in the station are obtained either from two station transformers, which are fed from the 132 kV switching station or from unit transformers, one of which is connected directly to each alternator. Generally speaking, supplies for essential auxiliaries are taken from the associated unit transfromer at 3·3 kV. Supplies for starting the turbines and boilers and for non-essential auxiliaries are taken from the station transformers at the same voltage, while smaller auxiliaries are supplied at 415 volts. All the 3·3 kV switchgear is of the air-break type and has a rupturing capacity of 150 MVA. It is installed in the same annexe as the transformers, but at the turbine-house operating floor level. Its control panels are set into the dividing wall between the turbine house and the switchgear annexe and are operated from the turbine room.

The principal contractors engaged in the construction and equipment of the station were:

Sir Robert McAlpine and Sons (Midlands), Ltd., West Bridge-street, Leicester, for the civil engineering; Spencer (Melksham) Ltd., Melksham, for the coal handling plant; Babcock and Wilcox, Ltd., Farringdon-street, London, E.C.4, for the boilers and ash handling plant; James Howden & Co. Ltd., Glasgow, for the air heaters and fans; Bailey Meters and Controls Ltd. for the automatic control equipment; and Sturtevant Engineering Co. Ltd., Cannon-street, London, E.C.4, for the electrostatic precipitators. The turbo-alternators, condensing plant and main, station and auxiliary transformers were manufactured by C. A. Parsons & Co. Ltd., Newcastle-upon-Tyne, and the 132 kV and 3·3 kV switchgear by A. Reyrolle & Co. Ltd., Hebburn, Co. Durham. The circulating water pumps were supplied by Drysdale & Co. Ltd., Glasgow, and the central evaporating plant by Aiton & Co. Ltd., Derby.

★ ★ ★

AUXILIARY ENGINES ON CLASS B FUEL

For convenience, many shipowners run their auxiliary Diesel sets on the same fuel as the main engines, thereby avoiding two sets of bunkers. Russell Newbery, Limited, Essex Works, Dagenham, Essex, have given some details of cylinder wear on nine of their 9-E6 engines which have been running on Class B Diesel fuel over the last 15 to 20 months. The engines are installed on a ferry service.

In the worst case, a wear of 0·003 in. on one axis was accompanied by one of 0·005 in. on the other on an engine which had run for 6,104 hours. The lowest rate was 0·001 in. after 3,760 hours. One of the other engines had a running time of 8,113 hours—the longest of all—for a wear of 0·002 in. and 0·004 in. on axes at right angles. (The nominal bore of these engines is 5·125 in.). Conditions that have been found necessary to give good running on the Class B fuel include pre-cleaning of the fuel to reduce nozzle and pump wear; not running the engine below 70 per cent. of full load; maintenance of a jacket temperature about 165 deg. F.; and finally, but not least, strict attention to oil filtering and changing.

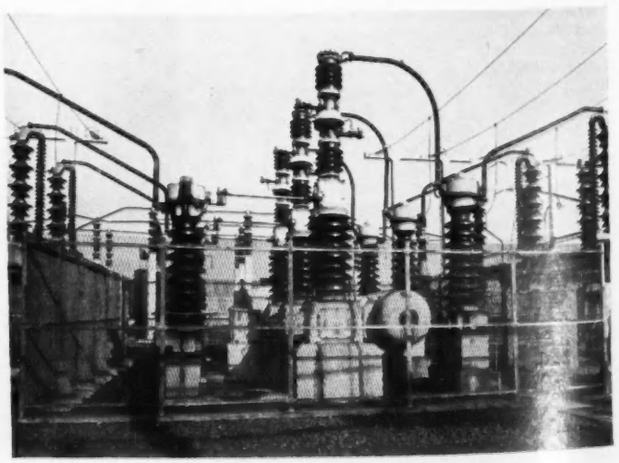

Fig. 5 132 kV outdoor switching station.

Book Reviews

SUPPLEMENTING NUCLEAR KNOWLEDGE

Progress in Nuclear Energy. Series I: Physics and Mathematics, Vol. I. Edited by R. A. CHARPIE, J. HOROWITZ, D. J. HUGHES and D. J. LITTLER. *Pergamon Press, Limited, 4-5 Fitzroy-square, London, W.1.* (84*s.*)

This book is the first of a series on progress which has occurred in the field of nuclear energy. It surveys most of the new information on nuclear and reactor physics that has been made known recently, particularly as a result of the 1955 International Conference at Geneva.

The first article, by J. A. Harvey and J. E. Sanders, reviews the experimental data on the thermal cross-sections and neutron yields of uranium 233, uranium 235 and plutonium 239. They make clear the distinction between effective and 2,200 metres per sec. cross-sections, which is essential to relate the various measurements that have been made, and a summary is given of suitable values of these constants for the fissile materials. A large number of experimental results on the resonance levels for neutrons with energies between 1 eV and 100 eV have been analysed by P. A. Egelstaff and D. J. Hughes, to obtain various parameters. The use of these parameters to predict cross-sections at higher energies is brought out in the following paper, by H. A. Bethe. Another article, by L. Cranberg and others, is on the experimental techniques for measuring elastic and non-elastic cross-sections for neutrons. These quantities are of importance in reactor and shielding studies. Xenon 135, a fission product, has a high capture cross-section for thermal neutrons. S. Bernstein and E. C. Smith give experimental values for the cross-section as a function of energy, and these enable the reactivity loss to be assessed for various temperatures in reactors.

A large number of thermal-reactor calculations involve two groups of neutrons; thermalised neutrons in one group, and all other neutrons lumped together in the second group. R. L. Macklin and H. S. Pomerance give calculated and measured values for this second group for about seventy nuclides. The initial response of a reactor at start-up and shut-down are determined by the relative yields and periods of delayed neutrons. G. R. Keepin reviews the experimental results on these, and makes comparisons with some present theories.

Results of critical assemblies of homogeneous aqueous solutions of uranium 233, uranium 235 and plutonium 239 are summarised by D. Callihan. This is an authoritative paper on the subject, and of great value in designing safe chemical plants for processing fissile materials.

For fast reactors, more sophisticated methods of calculation than diffusion theory have had to be developed, and these are described by J. Codd and J. H. Tait. Unfortunately, the cross-sectional data that is required in these methods is scanty. L. R. Shepherd, writing on experimental studies on fast systems, shows how many of the results can be interpreted by an intelligent use of asymptotic one group methods. S. M. Feinberg considers multi-lattices of regularly alternating elements. This is an interesting technique which would enable calculations to be made for cores in which fuel elements are alternately replaced by control rods or enriched rods. H. Hurwitz and R. Ehrlich in the final paper consider at length multi-group methods, as applied to intermediate and thermal systems. They conclude that the agreement between experiment and theory is good.

This is a stimulating book and should prove of great use in reactor design and operation. It is not, nor is it intended to be, an introductory course to this subject. Those, however, with a basic knowledge of reactor theory will find within it much to interest them.

NEW BOOKS

Some of the books noticed here are selected for extended review in ENGINEERING.

The Manufacture of Glycerol. Vol. III: The Modern Soap and Detergent Industry. By G. MARTIN. Second edition revised and enlarged by H. J. STRAUSZ. *The Technical Press, Limited, 1 Justice-walk, Lawrence-street, London, S.W.3.* (84*s.*)

Since the first edition of this book appeared in 1926, a number of advances have been made in the field of glycerol manufacture. The most important of these is the manufacture of synthetic glycerol, to which an entirely new chapter is devoted. Other additions include a description of the purification of glycerine by ion-exchange; the production of glycerol by hydrolysis of fats; and the production of glycerol substitutes by hydrogenolysis of sugar. The contents are divided into six sections under the headings: manufacture of crude undistilled glycerol; manufacture of distilled glycerol; miscellaneous methods of production; properties, technical applications and statistics; polymerised glycerol and glycerol substitutes; and commercial valuation and analysis. An index is included.

Industrial Research, 1956-57. Advisory editor, PERCY DUNSHEATH. Third edition. *Todd Publishing Group, Limited, 132-134 Fleet-street, London, E.C.4.* (63*s.*)

The main part of this book comprises a directory of those organisations in the United Kingdom concerned with the many aspects of industrial research. These organisations include Government and public bodies, research associations, development associations, professional and learned societies, producers and manufacturers, universities and technical colleges, private firms and research consultants. New sections in this edition include a chapter on atomic energy, giving details of overseas atomic energy authorities, and a directory of Commonwealth and overseas organisations interested in industrial research. The book opens with articles on various aspects of research by well-known authorities in this field. The closing chapters of the book are devoted to scientific and technical literature, including books, periodicals and abstracts.

Basic Design Temperatures for Space-Heating. Report of a Study Committee. Post-War Building Studies No. 33. Published for the Ministry of Works, by *H.M. Stationery Office, Kingsway, London, W.C.2.* (3*s.* 6*d.*)

After discussing the factors which affect the choice of basic design temperature for space-heating requirements, notes of guidance are given and also comparative methods used in other countries. One appendix is devoted to meteorological data statistics for eight different towns in the British Isles over a period of many years.

Fundamentals of Transportation Engineering. By ROBERT G. HENNES and MARTIN I. EKSE. *McGraw-Hill Book Company, Incorporated, 330 West 42nd-street, New York 36, N.Y., U.S.A.* (8.50 dols); and *McGraw-Hill Publishing Company, Limited, 95 Farringdon-street, London, E.C.4.* (64*s.*)

An attempt has been made in writing this book to give, within the confines of a single volume, a combined treatment of the principal divisions of transportation engineering: roads, airports, railways, rivers and coastal installations and pipelines and belt conveyors. The grouping together of the subjects is in keeping with current American teaching practice, but the result is a design handbook of fairly advanced level, taking account of recent developments and practices in the fields covered.

Éléments de Mécanique Quantique. By PH. PLUVINAGE. *Masson et Compagnie, 120 Boulevard Saint-Germain, Paris 6, France.* (4,000 francs.)

This volume, on the principles of quantum mechanics, is designed to provide an instructional course for research workers, experimenters, theorists and technical instructors. With this object in view, problems are set at the end of each chapter so that the reader can assess his understanding of the subject as dealt with up to that point. There are three main divisions: the atom in motion about an axis; the atom in space; and conceptions on atomic systems.

* * *

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Marine Diesel Engines. AKTIEBOLAGET GÖTAVERKEN, Gothenburg, Sweden. Single-acting two-stroke marine Diesel engines, up to 11,200 b.h.p. (normally aspirated) and 15,000 b.h.p. (turbo-charged). Speeds 112 to 160 r.p.m., and capable of running on boiler fuel. Also trunk-piston engines for auxiliaries up to 240 kW at 350 r.p.m. and the high speed "Top" engine of 2,800 b.h.p. at 950 r.p.m. Illustrated catalogue.

Engineers Cutting Tools. FIRTH BROWN TOOLS LTD., Speedicut Works, Carlisle-street East, Sheffield, 4. A 500 page catalogue of drills, mills, saws and files; reamers, taps and dies; shear blades and form cutting tools; turning, boring and planing tools; and cross-cut saws and mortising chisels. Covers the entire range of the company's manufacture.

Grain Drying and Conditioning. THOMAS ROBINSON & SON LTD., Rochdale. Hot-air type equipment for drying and conditioning grain. It consists, basically, of a column or columns which include feed, heating, blank, drying and conditioning, cooling and delivery units, and can be built up to suit particular requirements. Illustrated loose-leaf catalogue section.

Daylight Factor Meter. EVANS ELECTROSELENIUM LTD., 110 Potter-street, Harlow, Essex. The "EEL" B.R.S. daylight factor meter measures the ratio between the daylight illumination at a given position and the illumination simultaneously obtained out of doors from a completely unobstructed sky. Department of Building Research Station illustrated descriptive leaflet.

Electronic Recording Thermocouple Pyrometer. FIELDEN (ELECTRONICS) LTD., Wythenshawe, Manchester. A temperature recorder, which operates in conjunction with thermocouples, either of base or precious metal. The motor-driven fan is positioned by an electrical servo system from an electrical meter. Automatic and cold junction compensation is provided. Illustrated leaflet.

Power Hacksaw. QUALTERS AND SMITH BROTHERS, LTD., Old Foundry, Barnsley. Two-speed power hacksaw, 10 in. capacity, with hydraulic relief on return stroke. Machine runs at 75 or 100 strokes per minute, and is driven by a base-mounted, enclosed, 2½ h.p. electric motor, which also drives the coolant pump. Illustrated leaflet.

Flameproof Annunciator. SIEMENS-SCHUCKERT (Great Britain), Ltd., Great West Road, Brentford, Middlesex. Flame proof annunciator designed to give light and audible indications of dangerous conditions in hazardous atmospheres. Buxton certified for Groups I, II and III.

Control Gear. SQUARE-D LTD., 100 Aldersgate-street, London, E.C.1. Control gear including multi-pole relays, motor starters, push button units, limit and pressure switches, timing relays, thermal overload relays and voltage testers. Illustrated catalogue.

Crystallisation Plant. THE POWER-GAS CORPORATION LTD., Stockton-on-Tees. "Krystal" plant for producing material in crystalline form. Description of process and plant in English and French. Numerous diagrams, typical data, etc. Brochure.

Roller Chains and Wheels. RENOLD CHAINS LTD., Manchester. "Coventry" Mark 5 steel chains and wheels for slow-speed drives under rough conditions. Breaking loads up to 10,000 lb. Illustrated catalogue.

Diesel Engine Service. DAVEY, PAXMAN & CO. LTD. Standard Ironworks, Colchester. Service and spares organisation for oil engines in five continents. Manuals, parts lists, packing and dispatch. Publication No. 1450.

Telephone Loud Speaker. S. E. OPPERMAN LTD., Boreham Wood, Hertfordshire. Ampliphone electronic unit for telephone, with speaker microphone, loud speaker for incoming speech, socket for recorder, noise suppression, etc. Illustrated leaflet.

LIGHT-WEIGHT ALTERNATOR SET

STATIC EXCITATION GIVES CLOSE VOLTAGE CONTROL

To meet the growing demand for a light-weight alternator with a closely regulated output, the Brush Electrical Engineering Company Limited, Loughborough, have introduced a new range of machines with what is known as "Rectifex" control. Two sizes are already available.—100 kW and 150 kW—and a 250 kW machine is being developed. It is envisaged that models up to 400 kW will eventually be made. Fig. 1 shows the 100 kW version coupled to a Petter-McLaren air-cooled Diesel engine, with the control panel mounted above the alternator.

Mechanically, the alternator has a rotating yoke and a stationary central armature. This allows a considerable reduction in weight as the yoke is sufficient in most cases to replace the engine flywheel, and also a simplification of armature design with a reduction of iron losses. As may be seen from the drawing, Fig. 2, a cooling fan is mounted between the driving coupling and the yoke, and the ventilating system has large inlet and outlet areas. The large rotating mass also helps to dissipate heat. Another aid to the saving of size has been the use of silicone insulation throughout, allowing the alternator to run at higher working temperatures than are permissible with other forms of insulation, although the machine runs well below the 180 deg. C. recommended by the I.E.C. for silicone insulation. The 100 and 150 kW alternators have two bearings for the yoke, but in the 250 kW version there is only one.

STATIC EXCITATION

One of the main points in which the new machines differ from earlier ones, is the Rectifex control. The rotating exciter mounted on the end of the shaft has been abolished and replaced by a metal rectifier mounted within the alternator casing. This has permitted a reduction in length of about 2 ft. 6 in. as compared with the rotary type. The saving in length has resulted in turn in a large saving in weight due to the intrinsically lighter rectifier and also the shorter bedplate needed. It is one of the features of the Rectifex system that there are no moving parts, and all components are standard items of proven reliability. The complete circuit is shown in Fig. 3. As the field is supplied at full voltage, the slip rings can be quite small, for the current is only between 6 and 10 amperes.

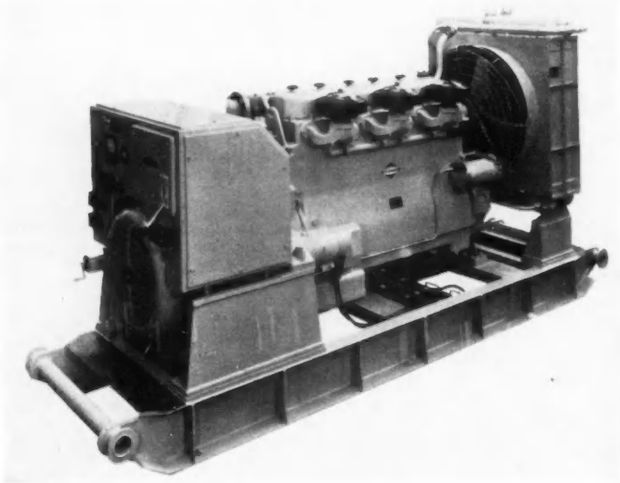

Fig. 1 The use of a rectifier instead of a rotary exciter, in conjunction with a rotating yoke has allowed the construction of a compact alternator and dispenses with a flywheel. A 100 kW Diesel engine driven set is shown here.

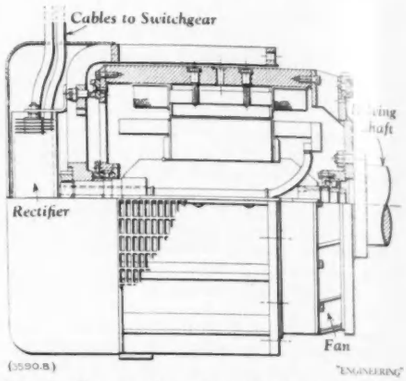

Fig. 2 Part section of a 100 kW alternator. The rectifier is cooled by the main air flow and silicone insulation is used to reduce size.

The main alternator field is supplied from the rectifier already mentioned, the input side of which is connected across the alternator output terminals through a transductor (variable reactance). The saturating winding of this transductor is supplied by a magnetic amplifier the input of which is derived from a voltage detector unit of the type fitted to Amplidex alternators, also fed from the alternator terminals. Thus any variation in alternator terminal voltage is fed to the detector, amplified, and applied to the saturating winding of the transductor, thereby varying its reactance and in turn the field current of the alternator.

Due to the relatively high forward resistance of the main rectifiers, it is necessary to boost the residual voltage of the alternator to ensure that voltage build up takes place. This is done by providing an auxiliary winding on the main transductor, which converts it into a transformer. This winding is energised through a starting relay, and is cut out of circuit when the voltage reaches such a value as to ensure satisfactory build-up. The voltage detector is provided with a filter circuit which ensures that any variation of alternator wave form due to loading does not cause errors, and the pre-amplifier has a very large amplification, achieved by current feedback and the use of high-grade core materials.

The steady state characteristics are good, and although a nominal regulation of only plus or minus 2½ per cent. is guaranteed, a much closer regulation than this is inherently possible due to the very large amplification of the system. Parallel running is possible with both similar and dissimilar sets, provided the latter have reasonably stable drooping voltage-load characteristics. Generally a three per cent. voltage droop from no load to full load is required, but this can be improved upon in many cases.

A further possibility of the Rectifex static excitation system is that in the event of failure of any of the components, other than the main rectifier, hand control can be arranged. The degree of cover, of course, depends on the stage in the system at which the manual control is applied. It can be arranged between the detector and pre-amplifier, between the latter and the transductor, or again, giving maximum cover, as a direct feed to the main rectifier.

During a series of tests carried out at the works, one of the 100 kW sets was run under varying conditions of load and power factor. Throughout the whole range from idling to full load and with power factors from 1·0 to 0·1 the voltage was held between 416 and 420. This control was maintained whether the set was

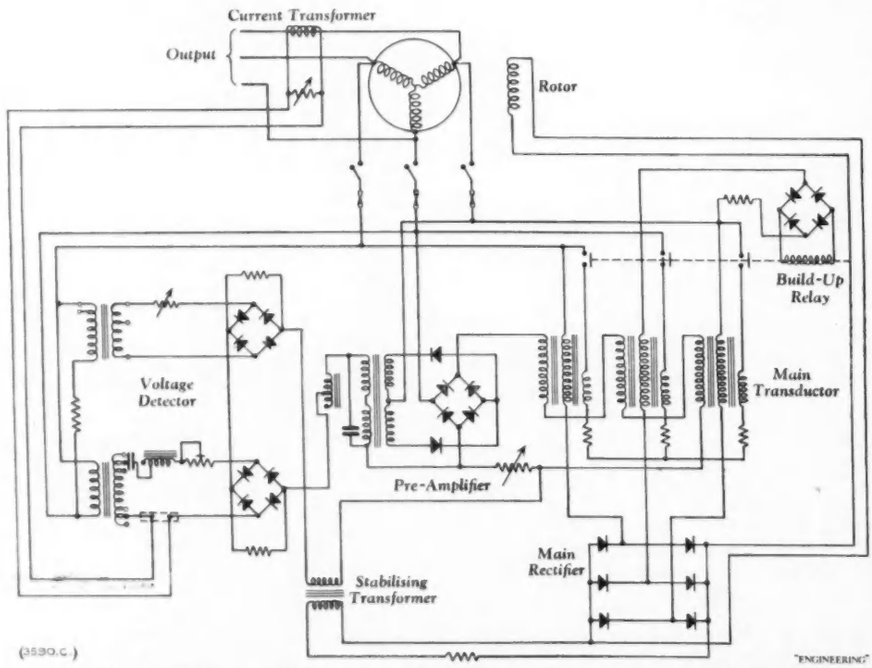

Fig. 3 Circuit diagram of Rectifex system of automatic control. Manual operation is possible in the event of failure of any component except the main rectifier.

running at 1,500 r.p.m. (50 cycles) or 1,800 r.p.m. (60 cycles). A 150 kW set was then started and synchronised, and this was followed by a 40 kW set using the Amplidex system of control. The load on the busbars supplied by all three was varied, and it was shown that the KVAR sharing of the sets was within 10 per cent. of the correct value. The astatic method of control of sharing was employed which uses differential compensating transformers.

The Iron and Steel Institute in France

ELECTRIC-ARC FURNACES AND INSTRUMENTATION IN STEELWORKS

The technical sessions of the special meeting of the Iron and Steel Institute, held in France from June 5 to 14, took place in Paris. On the morning of Wednesday, June 6, two simultaneous sessions "A" and "B" for the presentation and discussion of papers were held at the Chambre Syndicale de la Sidérugie Française, Rue de Madrid.

INSTRUMENTATION IN OPEN-HEARTH STEELWORKS

The first paper considered at Session "A" dealt with "Instrumentation in Steelworks" and Part I, on "The Open-Hearth Steelworks," was by Mr. G. Husson; and Part II, on "The Basic Bessemer Steelworks," was by Mr. P. J. Leroy. Both authors belong to the Steelworks Division, of the Institut de Recherches de la Sidérurgie (IRSID).

Mr. Husson stated that the essentials of the instrumentation of an open-hearth furnace should comprise: (*a*) automatic draught control ensuring constancy of pressure in the laboratory of the furnace, (*b*) manual control of the flow of the fuel, by the furnaceman, with a roof-temperature indicator, and (*c*) automatic control of the flow of air and, for heating by fuel oil, of the flow of the atomising agent, at a ratio to the gas flow which would leave the operator the opportunity of varying the excess air, checked by flue-gas analysis, according to furnace needs.

These fundamental measurements, obviously did not include others such as that of the pressure at different points within the furnace and the determination of the temperatures of the chequer chambers and of the gas in the flues. The furnaceman should know the temperature of the chambers to enable him to control reversal better.

DISCUSSION

The only speaker in the discussion, Mr. R. W. Evans, said that he could remember the day, not so very long ago, when the only instrument installed on an open-hearth furnace was a reversal indicator. Every time a reversal took place in the passage of the gas and air through the chequer work, a mark was made on a piece of paper. At the present time when the production had been much increased, a far greater load was put on the furnace refractories and the need for instrumentation was far greater. Air infiltration was an important factor and its determination was of great interest. A waste-gas analysis recorder was an instrument which steelmakers would find very useful. When oxygen enrichment was adopted, the volume of this gas put into the furnace could be measured, but it would be most interesting to have a record of the oxygen present in the burnt gases.

There were already some competitors of the open-hearth process of steel manufacture and perhaps during the next 20 or 25 years, this competition could become serious. The process, therefore, could only maintain its importance as a steelmaking unit if it were developed and perfected.

INSTRUMENTATION IN BASIC BESSEMER PRACTICE

Mr. P. J. Leroy, then presented Part II of the paper on instruments for basic-Bessemer steelworks. In this he described the volume Debitgraphe, a volumetric recording flow meter, for controlling the blast; a two-colour pyrometer and a time pyrometer for continuous temperature measurement during conversion; and the Opacimeter, for detecting the end-point.*

The object of the volume Debitgraphe, he stated, was to measure and record the flow of blast air through the Bessemer converter, not merely as a function of the time from the commencement of the blow, but also as a function of the total volume of blast already passed at any given moment. This decided the stage which the process had reached; and the variation of temperature and the time for making various additions should be governed by it. Moreover, a knowledge of the total blast volume also offorded the best possible control of the flow at any moment to limit loss by slopping.

The two-colour pyrometer was used for recording automatically the temperature of the metal from the commencement to the end of the operation. The flame pyrometer plotted a curve of the temperature of the converter flame, making corrections for its emissivity. This temperature was obviously related to that of the bath. Finally, the Opacimeter provided an indication of the end-point of the blow, based on the appearance of red smoke in the flame.

Owing to the advancing hour it was requested that contributions to the discussion and the authors' replies be in writing.

ELECTRIC ARC STEELMAKING PROCESS

The last two papers considered at session "A" on June 6, were discussed jointly after presentation. The first was entitled "Studies on a 10 cwt. Arc Furnace" and was by Mr. W. H. Glaisher, Mr. M. Preston and Mr. J. Ravenscroft, who are all at the Sheffield laboratories of the British Iron and Steel Research Association. The paper, which constituted a contribution from the Electric Process Subcommittee of the Steel Practice Committee of the Steelmaking Division of BISRA, described work carried out with a 10 cwt. Héroult arc furnace to determine the most economical operating conditions. The study was chiefly on electricity and electrode consumption and on roof wear, and was concerned principally with the melting phase of the process.

The authors stated that the condition of operation had been closely standardised and enough heats had been made under each set of conditions, for the significance of any differences in the results to be assessed. The major independent variables were power input during melting, electrode size, and the height of the roof. Power input during melting had been raised from 200 kW, which was very low for the furnace size, to 550 kW, which was very high. It had been found that increased power input reduced electricity consumption, increased roof wear, and had little effect on electrode consumption. The electrode sizes used were 4 in. in diameter, which was normal for the size of the furnace, and 7 in. which was very large. By comparison, the smaller electrodes resulted in reduced electricity consumption, reduced electrode consumption and reduced roof wear.

Two different roof heights had been obtained but neither could be regarded as more typical of normal practice than the other. By comparison, however, the lower roof very slightly reduced electricity consumption, reduced electrode consumption and increased roof wear.

For given conditions, electrode consumption had been found to be closely proportional to the surface area of electrode exposed within the furnace, indicating the greater importance of oxidation losses over the whole hot surface, as compared with the losses at the arcing point. Roof wear had been found to be closely related to the maximum temperature reached by the inside surface of the roof. If arc-furnace roof-temperature measurement could be developed to make it routine practice on production furnaces, the detrimental effects of high power input, during melting, and of other adverse conditions could be reduced or eliminated.

The second paper dealt with "Some Factors Affecting Electrode Consumption in the Electric Arc Furnace," and was by Dr. D. H. Houseman. The work described in the paper was carried out in the research laboratories of K. & L. Steelfounders and Engineers Limited, Letchworth Hertfordshire.

The author stated that the direct-potential-drop method of electrode resistivity measurement had been employed to sort 498 electric-furnace electrodes of 10 in. diameter into groups on a resistivity basis, in order to show that there was a direct and statistically valid relationship between electrode resistivity and electrode consumption in the two basic arc furnaces used in the investigation. The two furnaces had a nominal capacity of 5 tons and had an input of 3,500 kVA. Long-term trials, using only electrodes of low and medium resistivity, had shown that large savings were possible in electrode costs.

As electrode consumption decreased, power costs per ton of steel produced might rise; this rise, however, was more than offset by the fall in electrode costs, so that a large net saving resulted from using low-resistivity electrodes.

DISCUSSION

Mr. D. F. Campbell, who opened the discussion, said that it was appropriate that these papers should be discussed in Paris, because the Héroult furnace had originated in France, and, at the present time, the 50th anniversary of the production of steel in the arc furnace was being celebrated in America. Nowadays, practically every furnace used in steelmaking was of the Héroult type. It was generally recognised that the manufacture of electrodes was not altogether satisfactory, for one thing, they were not homogeneous.

The paper produced by BISRA would give electric steelmakers a great deal of food for thought and contained much information. The data furnished would have to be investigated and adapted to practical conditions on the melting-shop floor.

When designing an 80 ton furnace at the present time, it was necessary to decide whether to give it a capacity of 15,000, 20,000 or 25,000 kW. The capacity chosen depended on the contract price for electric current and other factors.

Mr. F. H. Pensa said that the resistivity of an electrode in a longitudinal direction was different from that in a transverse direction. More important than the resistivity, however, was the question of its resistance to impact. In fact the two factors which required careful investigation were those relating to the handling and storage of electrodes.

The last speaker, Mr. R. Ferry, asked Mr. Glaisher and his colleagues regarding the five thermocouples which they had placed at various positions in the roof of their furnace so that the distribution of temperature over the inside surface could be observed. He wondered if these wore out rapidly.

To this question Mr. Glaisher replied that they lasted for from 24 to 48 hours, after which the pyrometer sheaths became saturated with oxide of iron. Recently, however, they had been experimenting with a silicon-carbide sheath

* It will be recalled that these instruments were described in a paper presented by Mr. P. J. Leroy, Mr. J. G. Galey and Mr. F. B. Cawley at the recent annual general meeting of the Institute as reported on page 463 of our issue of June 8, 1956.

having outside it an alumina sheath and interesting results were being obtained.

EFFECT OF GRAVITY ON SOLIDIFICATION OF STEEL

Two papers were presented before session " B," on Wednesday, June 6, and the first, " The Effects of Gravity in the Solidification of Steel," by Mr. B. Gray, of the English Steel Corporation Sheffield, had already been presented at the annual general meeting of the Institute, in London, on May 17. The paper described the macro-structures obtained in a series of vertically-cast bottom-poured steel ingots having different feeding arrangements. The author stated that he had found that these modifications had led to important changes in the mechanism of the crystal growth in the solidifying steel. These changes were effective in the earliest stages of freezing and could only be caused by convection currents. In nearly all the mechanisms proposed in the past, a major difficulty had been to explain how the heat of freezing was dissipated in equi-axial formation. It had been found that, in vertical castings, nearly all such freezing took place in the current at the walls, so that the heat was dissipated through them.

V-segregates were not caused by the materials being sucked down in the centre of the casting, as often suggested, but were traces of the natural angle of repose of such loose materials. The crystals piled up against the walls of the casting and periodically collapsed across it to the centre.

ELECTRON PROBE MICROANALYSER

The second paper presented at session " B " was entitled: " Applications of the Electron Probe Microanalyser," and was by Dr. J. Philibert and Professor C. Crussard of the department of physics of the Institut de Recherches de la Sidérurgie. The authors stated that the Castaing-Onera microanalyser with electronic probe invented by Mr. R. Castaing and constructed by the Office National d'Etude et Recherches Aéronautiques, was intended for making quantitative analyses of elements at points in massive specimens, metallic or otherwise. Its principle was, briefly, that an extremely fine pencil of electrons (the electron probe) was directed at the specimen and the characteristic X-rays emitted by the specimen under the impact of the electrons were analysed. The apparatus therefore consisted essentially of an electron optical system and an X-ray spectrometer. A mirror-objective microscope permitted normal observations of the specimen, prepared as for metallography, to be made.

The extent of the " resolving power " of the apparatus was 2μ in length (this being the minimum diameter of the region analysed) and 1 to 2μ in depth. All elements heavier than chlorine (atomic No: 17) could be determined, and the extention to elements down to aluminium and magnesium was being studied. The analysis of very light elements, such as carbon, nitrogen, and oxygen was not envisaged at present.

Used alone, the instrument's field of application was quite wide but, when used in conjunction with a method for revealing the distribution of elements with which it could not cope (light elements like carbon, nitrogen and oxygen, or elements in relatively-low concentrations, such as phosphorus and sulphur in steels) interesting results might be expected concerning the solid-state interaction of certain metallic elements with the non-metals always present in alloys.

Subsequent sessions of this meeting will be reported in due course.

PULSE CHARGED TWO-STROKE DIESEL ENGINE

SCAVENGE PUMP ELIMINATED AND POWER INCREASED

Believed to be the first American-built two-stroke Diesel engine to be successfully fitted with pulse turbo-supercharging is a Kahlenberg Model E marine engine, originally fitted with a mechanically-driven scavenge pump but now equipped with a turbo-blower made by D. Napier and Son, Limited, The Vale, Acton, London, W.3, which acts both as super-charger and scavenger.

The Kahlenberg engine, which is illustrated in Fig. 1, was originally developed under mechanically scavenged conditions to have a rating of 512 b.h.p. at 325 r.p.m., with a mean effective pressure of 75 lb. per sq. in. The supercharged version, as finally developed, is rated at 700 b.h.p. and 103 lb. per sq. in. b.m.e.p. at the same speed. The use of the pulse system, in which the turbo-blower takes the exhaust gases at practically the same pressure and temperature as they are discharged from the cylinders, allows the scavenge pump to be dispensed with, as a fall in exhaust manifold pressure after each pulse allows sufficient scavenge air to pass through the cylinders to give good cleansing and also cooling of the piston and combustion space. From available knowledge it would appear that a constant pressure system would not be capable of providing sufficient power to dispense with the scavenge pump entirely. The engine exhaust manifold was divided into two halves so that succeeding exhaust pulses should not interfere with each other and prevent scavenging of the cylinders.

Initial tests showed that the engine would start quite quickly and easily without the assistance of an auxiliary blower, and maintain good combustion characteristics through the speed and load range. These are shown in the curves given in Fig. 2. Examination of the curves shows an appreciable reduction of specific fuel consumption over the whole range of power, particularly at pressures of 80 lb. per sq. in. b.m.e.p. and upwards, where the normally-aspirated engine shows a marked increase in consumption while the supercharged version is still decreasing. The curves also show that the scavenge air pressure increases with duty, which is a characteristic of turbo-charged engines and is reflected in the tendency for the exhaust temperature to fall with increasing load.

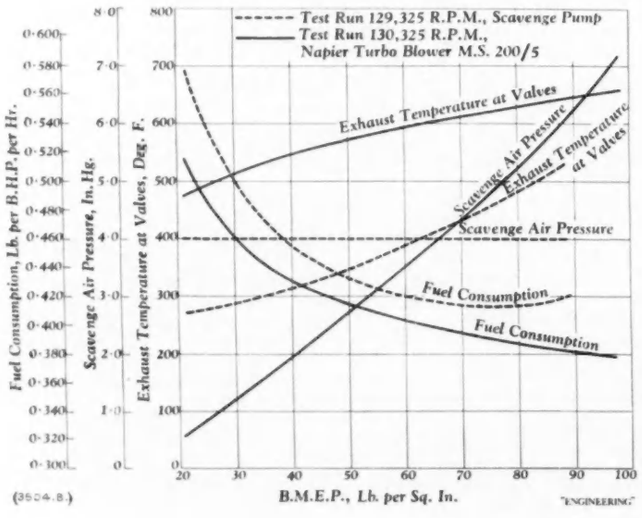
Test Run 129,325 R.P.M., Scavenge Pump
Test Run 130,325 R.P.M., Napier Turbo Blower M.S. 200/5
Exhaust Temperature at Valves
Scavenge Air Pressure
Exhaust Temperature at Valves
Scavenge Air Pressure
Fuel Consumption
Fuel Consumption
Fuel Consumption, Lb. per B.H.P. per Hr.
Scavenge Air Pressure, In. Hg.
Exhaust Temperature at Valves, Deg. F.
B.M.E.P., Lb. per Sq. In.
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Fig. 2 The performance curves show an improved fuel consumption throughout, particularly at higher powers.

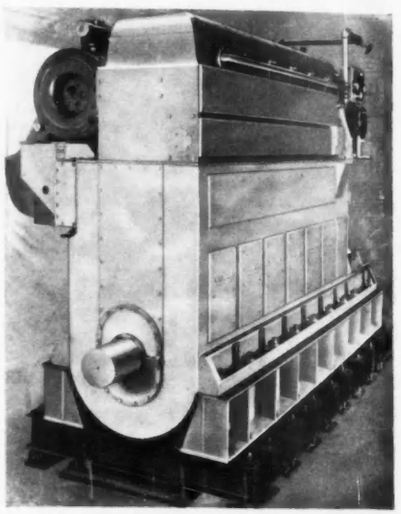


Fig. 1 By fitting a turbo-blower and using the exhaust pulse system, it has been possible to dispense with the scavenge pump and at the same time raise the output by nearly 50 per cent.

★ ★ ★

INDUSTRIAL X-RAY UNIT

Philips Electrical, Limited, Shaftesbury-avenue, London, W.C.2, have designed an industrial X-ray equipment for use in non-destructive testing problems. The apparatus is in two main parts: the tube head and the control unit. The former consists of a cylindrical tank which contains the oil-immersed and water-cooled X-ray tube, a filament transformer and the high-tension transformer. The connections from it to the control desk are all at mains tension. As the tube head is only 40 in. long by 14½ in. in diameter it can be passed through narrow apertures.

The controls consist of a kVp or penetration selector, which is stepless from 50 to 150 kV; a milliampere selector, which is also stepless; a synchronous motor exposure timer with a range of 0 to 30 minutes; a mains voltage compensator; milliampere and kilovolt meters; indicator lamps, which show " no water flowing"; and push buttons for switching the mains and high-tension supplies " on " and " off."

The equipment described, which is known as the Compactex 150, is rated at 150 kVp and 10 milliamperes. It will operate at any mains voltage befween 200 and 250 volts alternating current and, complying with the international recommendations on X-ray protection is both ray-proof and shock-rpoof. It can be slung either vertically from a hoist or crane or can be mounted on a mobile stand. For transport purposes the tube head can be fitted into the boot of a small car and the control unit carried on the rear seat.

THE MACHINE TOOL INDUSTRY

The International Machine Tool Exhibition for 1956 opens in London today. Since its predecessor was held in 1952, probably the two most important developments have been the growth of international competition and the appearance of control systems employing electronic or other techniques. These factors add a special interest to this year's exhibition. Progress has also been made in automatic handling, leading to what is loosely known as automation; feed and cutting speeds have generally increased so that considerable emphasis has been laid on robust construction; improvements have been achieved too in the use of profiling and copying techniques, both as built-in systems and as attachments; and finally there has been considerable refinement in mechanical and electrical measuring equipment, thus permitting more accurate repetition of component form and size. These developments may be summarised in the three qualities which a potential machine-tool buyer is likely to seek: speed, accuracy and consistency. It might be interesting to consider why firms buy machine tools, how they decide when a replacement or an addition is due. Fundamentally, machines serve to give a greater yield or turnover when other factors such as labour and floor space are fixed; a company might invest in more machine tools, for example, when it wished to obtain a greater output from an existing labour force. This aspect has, however, already received considerable attention, but an approach which has yet, perhaps, to be fully explored by the British machine-tool industry is the use of machines to economise in floor space. In any case, the opening of the Machine Tool Exhibition presents an ideal opportunity for companies which employ machine tools to review their needs. The exhibition, which will be held at Olympia from June 22 to July 6 and is organised by the Machine Tool Trades' Association, will show the products not only of British companies but also of Continental and American manufacturers. In view of the interest created by the exhibition, we are publishing a series of articles dealing with different branches of the machine-tool industry. Each article will be devoted to a particular group of tools or operations, milling machines, for example, or sheet-metal working, and wherever possible some indication of the trend in development will be given. Most of the equipment touched upon in the series will be on view at the exhibition, though there may be certain exceptions. The first article, which follows, will deal with machine-tool control systems.

AUTOMATIC CONTROL SYSTEMS

The word automation has been used so loosely that it is sometimes difficult to distinguish between the various mechanical, hydraulic and electronic techniques which are generally included under that heading and which are increasingly becoming important features of machine-tool design and application. Some authorities regard automation simply as the use of automatic handling methods as in transfer machines where the work is held in a mobile fixture and passed from one operating position to another. More usefully perhaps, automation might be defined as the use of power to control power, as when electronic or servo devices are employed to govern the motion of a machine-tool cutter with respect to a workpiece. Essentially, however, it is a group of techniques which serve to reduce the man-hours necessary for making any product or component, and is therefore as old as engineering itself.

In the article which follows, we propose to neglect the inter-tool handling aspect, since this is not inherent in the actual tool, and consider only those techniques which can be built into the machine. These may be divided into four main categories: control systems, by means of which drawings can be translated into finished workpieces with the minimum of human interference; programme units which permit a given sequence of operations to be performed at a number of predetermined machine settings; mechanisms which automatically feed and discharge the workpieces to and from the tool; and profiling and copying devices. Much time is required in machining for such non-productive operations as setting up, loading, gauging and checking and it is here that these techniques can be of most value. Moreover, whereas automation is often thought to be only relevant to products required in large quantities, the first of these categories applies especially to small-number production. There are also various combinations and mutations of the four techniques: in a sense, electronic control systems in the first category combine the advantages of programming and profiling plus ease and economy of tooling, while automatic lathes—which will be treated separately in an article on turning—employ in effect both a simple programme and mechanical means of feeding the workpieces.

In the present article we shall select at random and describe a number of typical systems and machines which illustrate these principles, many of them will be demonstrated at the International Machine Tool Exhibition. Other equipment in these categories may be described in later articles devoted to particular types of machine.

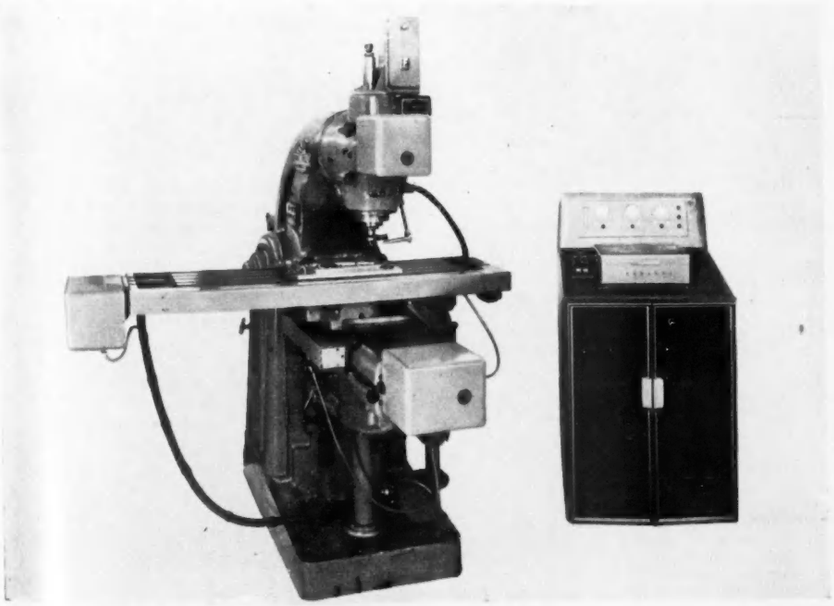


Fig. 1 Ferranti electronic control system applied to vertical milling machine, showing the control unit (right). The system enables a complete component to be machined without human interference.

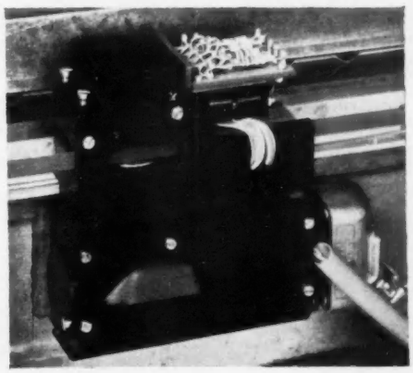


Fig. 2 Optical unit and section of diffraction grating for measuring and controlling movement of milling-machine table (Ferranti).

ELECTRONIC CONTROL

The Ferranti System.—Where it is necessary to machine components in small numbers with considerable accuracy, as in the aircraft, tooling and other industries, the use of human skill in conjunction with expensive tools, jigs and fixtures has long been considered the only practical approach. However, with the advent of electronic techniques it may be possible to abandon such costly methods, since with their aid the whole process can be reduced to the preparation of a drawing and planning sheet, and the operation of an instrument resembling a typewriter.

In the Ferranti system, the essential elements are as follows: an electronic digital computer capable of providing a service to a large number of machines; a control unit associated with the machine tool and its servomotors as shown in Fig. 1; high-performance servo-mechanisms utilising the measuring system as feedback; and an electro-optical method of measurement employing a long diffraction grating and having an inherent accuracy superior to that of the machine tool with which it is used; these items can be seen in Figs. 2 and 3. There are five principal stages in the operation. First a drawing is prepared, preferably dimensioned in a form suitable for the system; a typical example appears in Fig. 4. From this a planning sheet is prepared, similar in general layout to that represented in Fig. 5, and the information it records is then transferred to punched paper tape such as that illustrated in Fig. 6 by means of machine having keys like a typewriter. This serves as input to the computer which prepares a magnetic control tape. Finally the tape is

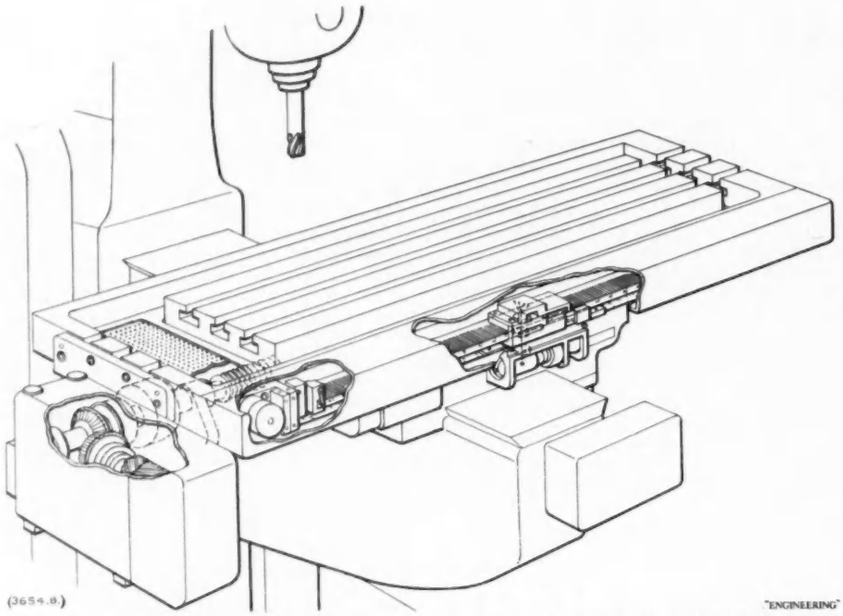
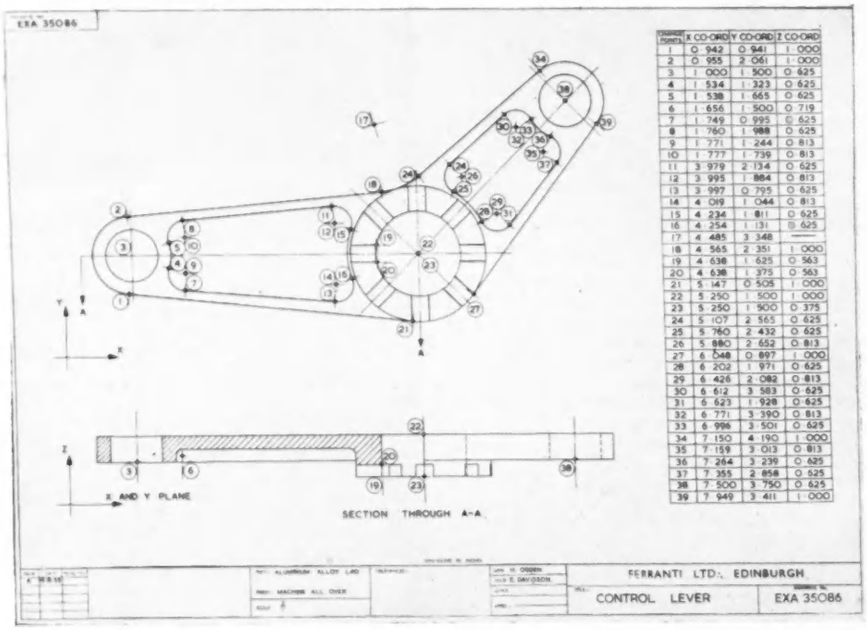


Fig. 3 Drive unit and measuring equipment associated with one slide of milling machine (Ferranti).



	X CO-ORD	Y CO-ORD	Z CO-ORD
1	0·942	0·941	1·000
2	0·955	2·061	1·000
3	1·000	1·500	0·625
4	1·534	1·323	0·625
5	1·538	1·665	0·625
6	1·656	1·500	0·719
7	1·749	0·995	0·625
8	1·760	1·988	0·625
9	1·771	1·244	0·813
10	1·777	1·739	0·813
11	3·979	2·134	0·625
12	3·995	1·864	0·813
13	3·997	0·795	0·625
14	4·019	1·044	0·813
15	4·234	1·811	0·625
16	4·254	1·131	0·625
17	4·485	3·348	—
18	4·565	2·351	1·000
19	4·638	1·625	0·563
20	4·638	1·375	0·563
21	5·147	0·505	1·000
22	5·250	1·500	1·000
23	5·250	1·500	0·375
24	5·107	2·565	0·625
25	5·760	2·432	0·625
26	5·880	2·652	0·813
27	6·548	0·897	1·000
28	6·202	1·971	0·625
29	6·426	2·082	0·813
30	6·612	3·583	0·625
31	6·623	1·928	0·625
32	6·771	3·390	0·813
33	6·998	3·501	0·625
34	7·150	4·190	1·000
35	7·159	3·013	0·813
36	7·264	3·239	0·625
37	7·355	2·858	0·525
38	7·500	3·750	0·625
39	7·949	3·411	1·000

Fig. 4 Method of detailing drawing for use with Ferranti system, showing origin and co-ordinates.

used in the control equipment to determine the continuous movements of each axis of the machine tool. It is claimed that, with high spindle speeds and excluding tool changes, once the magnetic tape has reached the control equipment, a component can be made in 7 minutes which would formerly have taken a skilled operator 12 hours.

As previously reported in ENGINEERING (vol. 177, pages 263 and 766) the basic element in the measuring system is a long diffraction grating marked at right angles to its length with a precisely known number of lines, and fixed to the table of the machine tool. When the grating is superimposed on another shorter grating slightly inclined to it, a Moire fringe pattern is produced which travels across the gratings as they are moved relative to one another. The dark bands are detected by photo-sensitive elements which convert the light intensities into signals of equivalent intensity. These waveforms serve to form a digital measuring system of two pulses per grating line and to provide means of effecting a feedback control through servomotors of the table movement. There is of course, one long grating for each axis of motion. Gratings currently in use are marked with up to 5,000 lines per inch giving measurements to an accuracy of 0·0001 in.

The servomotors are three-phase 400 cycles per sec. induction motors delivering 0·5 b.h.p. at 10,000 r.p.m. and fed by high-performance magnetic amplifiers. A magnetic drum brake is fitted to lock the slides when the motors are de-energised; the brake also operates as an emergency stop if the machining tolerances are exceeded or when the limits of travel of the slides are reached. Each motor drives through a backlash-loaded gearbox. The reduction train is designed to offer minimum inertia loading to the servo-motor. Lubrication is by oil mist, with the cast gearbox casing forming a sump. The reduction ratio of the standard gearbox gives an output shaft speed of 120 r.p.m. at peak motor power. This shaft is arranged to drive in three alternative planes to allow for variation of machine geometry, and a self-aligning torque-limiting coupling is fitted to safeguard the gearbox from overload. A typical layout of gearbox and measuring system on one slide of a vertical milling machine is shown in Fig. 3.

In preparing the drawing and the planning sheet, the basic consideration is the co-ordinate nature of the control system. Thus an origin must be given, as indicated in Fig. 4, and co-ordinates of all change points must be shown. It should be noted that for a curve its nature should be stated, whether circle, ellipse, parabola or hyperbola (see Fig. 5), and its

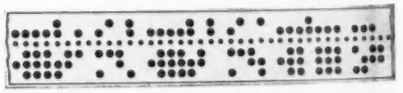


Fig. 6 Punched paper-tape. Data on tape is transferred by a computer on to magnetic tape, which passes to the control unit (see Fig. 1).

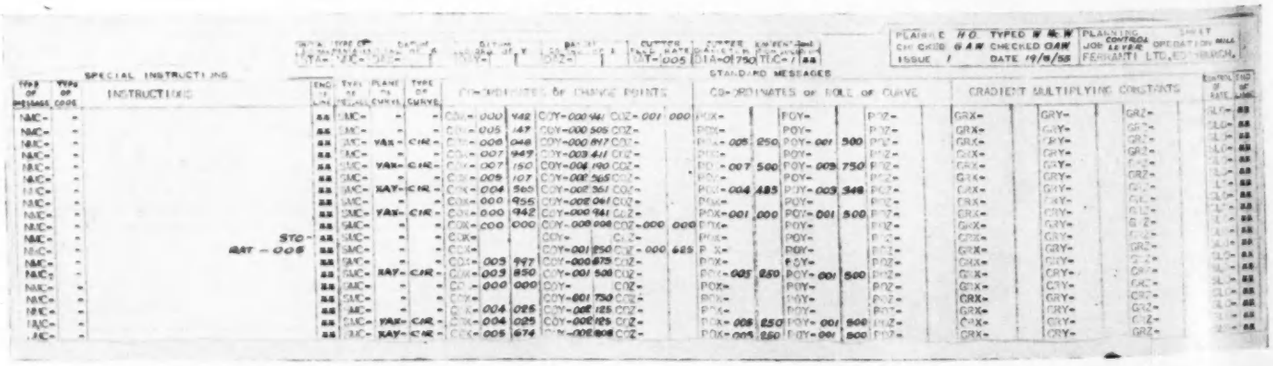


Fig. 5 Planning sheet prepared from special drawing (see Fig. 4). The data it gives is then transferred to paper tape (see Fig.

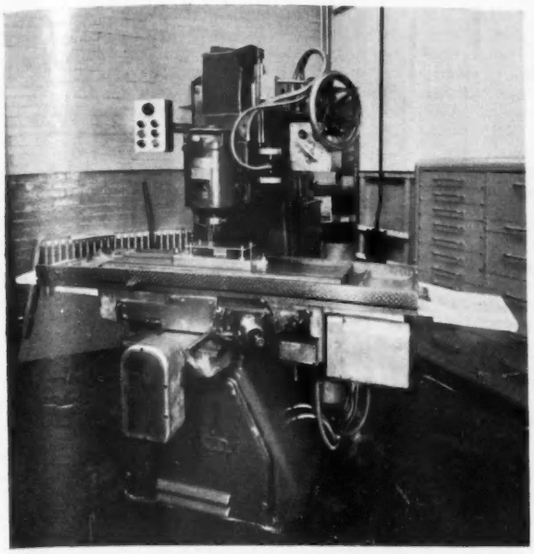


Fig. 7 E.M.I. electronic control system; control unit on right.

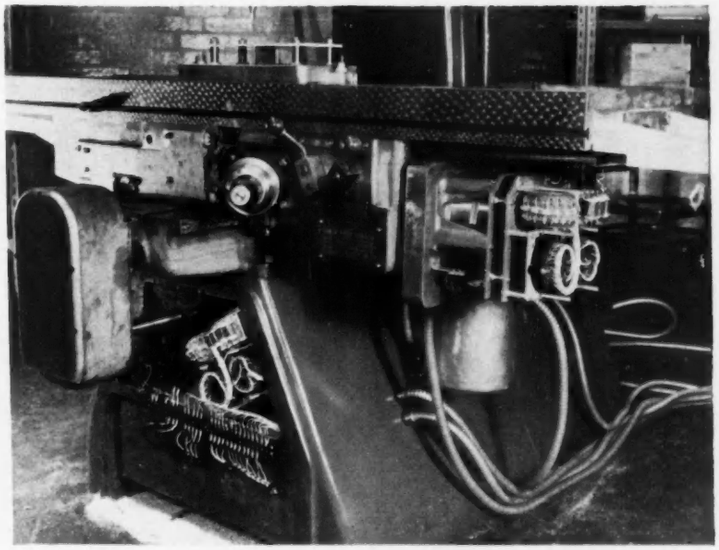


Fig. 8 Detail of E.M.I. system (see Fig. 7) as applied to Wadkin miller.

pole indicated. Finally the basic machining information must be recorded, such as feeds and speeds. Once the planning sheet has been completed no more skilled operations are required and after the data have been encoded cutting can proceed. It has been found that the overall saving in time can be in excess of 5 to 1, while the only limitation on precision is that entailed by the machine tool.

The E.M.I. System.—Another control system employing electronic techniques is that being demonstrated at the Machine Tool Exhibition on the stand of Wadkin Limited, of Leicester. The E.M.I. system is believed to be of almost universal application and has already been successfully applied to four types of machine tool: the Cincinnati Hydrotel, the Cincinnati No. 3 Vertical Miller, a high-precision copy miller made by Research Engineers Limited, and a Wadkin high-speed vertical miller. The Research Engineers profile miller and its associated equipment was described in ENGINEERING, vol. 180, page 769, 1955, and the Wadkin machine, which is shown in Figs. 7 and 8, will be demonstrated at the exhibition. Fig. 7 shows the adapted high-speed miller with, on the right, the control unit; and Fig. 8 shows a detail of the table control mechanism. The E.M.I. system, which also employs a computer and servo-mechanisms to control the feeds, enables the machine tool to cut two or three dimensional shapes without the use of templates or other patterns and has the advantages of a copying machine with the added benefit that short runs can be performed as economically as longer runs. It is therefore suitable for production of master cams, templates and prototype parts.

In principle, the action of the electronic control system is to direct the tool in a smooth path through a number of points specified by the designer and designated by co-ordinates. In the machine exhibited these points are spaced approximately $\frac{3}{8}$ in. apart along the profile, but larger point spacings are permissible, depending upon the accuracy required and the complexity of the part. The points, which can be specified in rectangular or polar co-ordinates according to convenience, are listed in the form of a table of dimensions and recorded on perforated tape in a decimal binary code. The tape is then fed into the control unit, where analogue circuits perform a parabolic interpolation and deduce from the relatively small number of "marker" points in the table the large amount of subsidiary information required in order to cause the machine to cut a smooth profile through the specified points. No elaborate external computer is therefore required. The system makes use of position control, whereby each dimension encoded on the tape is measured separately from the same datum point on the machine tool. Cumulative errors are thus eliminated. The cut is both true and smooth, and requires no subsequent blending or hand-finishing. An important feature of the E.M.I. system is that an additional unit can be supplied, if required, to provide compensation for cutter diameter wear, thus allowing resharpened cutters to be used without the preparation of new tape.

The Wadkin machine has been modified by the attachment of servo-motors to the longitudinal and transverse feeds in place of the normal hand feeds, and a third motor for raising and lowering the head. This is controlled by an extra set of information punched on the paper tape, and gives the system the additional facility of cutting pockets within the profile specified for the workpiece. The electronic control system is designed to operate over the standard range of

Fig. 9 Matrix No. 150 jig borer fitted with electronic linear measuring system developed by Mullard Research Laboratories. Table position set by dials on console (left) and indicated by lights above dials. Push-button controls on front of table (Coventry Gauge and Tool Co., Ltd.).

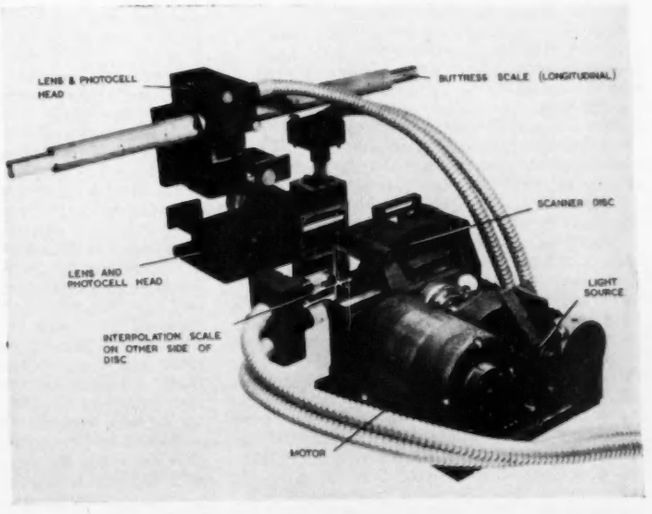


Fig. 10 Flying line scanner and buttress scales for Matrix jig borer (see Fig. 9). Interpolation between the 0·1 in. sawtooth pitch of the buttress scales is performed optically by means of the scanner, so that settings can be made in both directions to within 0·0001 in.

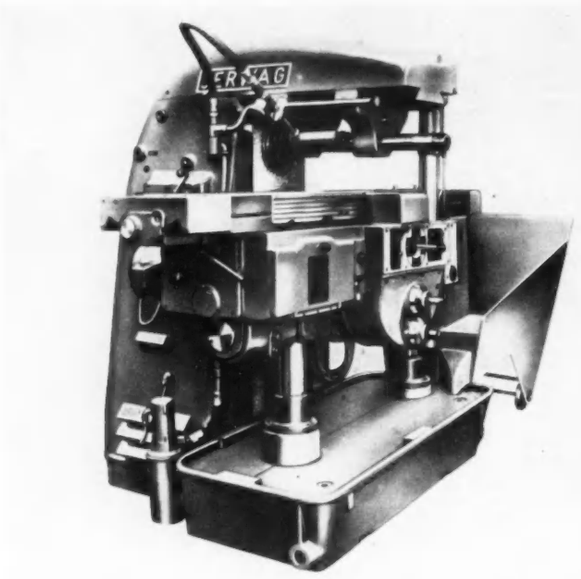


Fig. 11 Jerwag climb cut programme control milling machine with table movement governed by metal tape (Stuart Davis Ltd.).

cutting speeds of the machine, which is a high-speed tool for fast cutting and routing of light alloys. Accuracy is achieved by taking position-control measurements from the recirculating ball nut leadscrews. The accuracy of the information supplied by the control unit is greater than 0·001 in. on dimensions of up to 100 in. The system has been designed by E.M.I. Electronics Limited, Hayes, Middlesex.

PROGRAMME SYSTEMS

Somewhat simpler than the continuously controlled electronic machines are those which can perform a given sequence of different operations in accordance with a fixed programme without repeated setting up. In other words the co-ordinate position of the cutting tool is set for each operation without intercession of the operator. Such machines may be controlled by punched cards (see ENGINEERING, vol. 177, page 377, 1955), metal tapes, paper tapes, film strip, and possibly other means. Though they are intended primarily for quantity manufacture, they may often be suitable too for small-number or prototype production.

Matrix Jig Borer.—Although the "Matrix" No. 150 jig boring machine is not strictly a programme-controlled unit, it is in fact a step in the evolution of a jig borer with automatic positioning. It makes use of an electronic linear measuring system for locating the table and extensive push-button controls, and has been developed by the Coventry Gauge and Tool Company, Limited, in conjunction with the Mullard Research Laboratories. Settings can be made in both directions to within 0·0001 in.

The internal standards of length in the Matrix No. 150 take the form of steel buttress scales, each consisting of a solid steel bar into which is accurately cut a sawtooth form of 0·1 in. pitch. A step, machined lengthwise, reveals the form consisting of upright and sloping edges, and the maximum adjacent pitch error is 0·00002 in. The scale is rugged and durable being machined from a single piece of material; it also has the same coefficient of expansion as the rest of the machine. Interpolation between the 0·1 in. steps of the master scale is accomplished optically. A glass scale a little over 2 in. long carries upwards of 1,000 alternate opaque and transparent bars, equally spaced. These are scanned by a moving line of light and the projected image reduced optically by a factor of 20 so that 1,000 bars fit exactly between adjacent vertical edges of the buttress scale. As the table is driven, the bars are counted as they emerge from behind a vertical edge by means of photo-multiplier tubes and an electronic counter. The number counted is subtracted electronically from the required number and the error displayed on a row of dial lamps. When the error is reduced to zero the central lamp lights and the table is clamped by operating a push-button.

The opaque and transparent bars on the glass interpolating scale are scanned four times per second by a line of light produced by a specially designed scanning mechanism, known as a flying line scanner. The light originates from a line filament prefocus car headlamp bulb. A condensing lens provides a beam of parallel light wide enough to illuminate the glass scale over its entire length. The scale is, however, shielded from the light, which can only reach it through one of four glass rod lenses mounted in the centres of four planet gears which form part of an epicyclic gear train. The scanner makes use of the fact that in an epicyclic gear train, if the sun gear and carrier are driven at the correct relative speeds, the plane gears, while moving round the sun, do not rotate about their own axes. With large diameter ball races for the planet bearings, the centre of the gears can be bored out and rod lenses mounted in them at right angles to the gear axes. While the rod lenses move in a circular path, they remain upright, and by using a lens longer than $\frac{3}{8}$ in., an arc of motion can be selected such that the 2 in. by $\frac{3}{8}$ in. scale is fully scanned from end to end.

The equipment, which embodies many additional refinements including push-button control of table speed and magnetic clutches, is shown in Fig. 9. The last three digits of the desired table position in 0·0001 in. units are set up on dials of the electronic console on the left, while indication of position is given by a row of lamps above these dials; push buttons for controlling machine functions are on the panel in front of the table. A close-up view of the flying scanner and buttress scales appears in Fig. 10.

Jerwag Miller.—More correctly described under programming, perhaps, is the Jerwag climb cut programme-control milling machine, which combines the virtues of automatic operation with the advantages of climb milling. The machine is designed to absorb the stresses set up when metal is removed at high rates; for instance, the patent double lead screw on the table removes the necessity for back-lash eliminators and the over-arm support is a one-piece casting integral with the body. Provision is made for chip and swarf removal by a sloping table. These features, though not peculiar to automatic or programme machines, are nevertheless essential to any system where speed is to be a maximum and operator supervision a minimum. The work cycle is controlled by a metal tape arranged for a particular job or series of operations, which may be easily interchanged with others. It controls automatically the following movements: 1. change from rapid traverse to feed rate or conversely; 2. lowering of table up to 5·2 in. at end of feed; 3. rapid return of table; 4. raising of table for commencement of feed; and 5. stopping of spindle and table feed at end of cycle. The table is 65 in. by 14in. in area and has either 12 or 24 speeds ranging from 28 to 1,900 r.p.m. Stuart Davis Limited, of Much Park-street, Coventry, are agents for this machine, which can be seen in Fig. 11.

FEEDING AND CHECKING

The grinding process is also capable of automatic operation and may be used to illustrate not only the pre-setting of work cycles but also the automatic feeding and checking of workpieces.

Reinecker Internal Grinder.—Shown in Fig. 12, the Reinecker J.P.S.A.O. automatic internal grinder (agents, Stuart Davis Limited), which has a nominal capacity of 2 in. diameter by 4 in., with a chucking capacity of 6½ in. diameter and is the smallest of a range, has fully automatic operation, and can be combined with either direct or indirect methods of measurement. With the face grinding attachment, which is fed and retracted hydraulically, workpieces can be finished at one setting. There are four work speeds, 320, 450, 640, and 900 r.p.m., and grinding spindles operating up to 60,000 r.p.m. can be fitted. Table reciprocation, wheel feeds and other functions are electro-hydraulically controlled. The work cycle may be easily and rapidly set from controls on the front of the machine, and it is claimed that every variation of cycle required in internal grinding can be performed. An interesting feature is the wide grinding angle possible: 30 deg. on a standard machine and 60 deg. by a special arrangement.

Scrivener Automatic Systems.—Among the most comprehensive ranges both of workpiece feed and sizing devices and of controlled-cycle centreless grinding machines to be shown at the exhibition are those developed by Arthur Scrivener Limited, Tyburn-road, Birmingham. To feed workpieces delivered at random into a grinding machine correctly positioned with the large end first, a vibratory hopper has been designed, from which the items pass down an

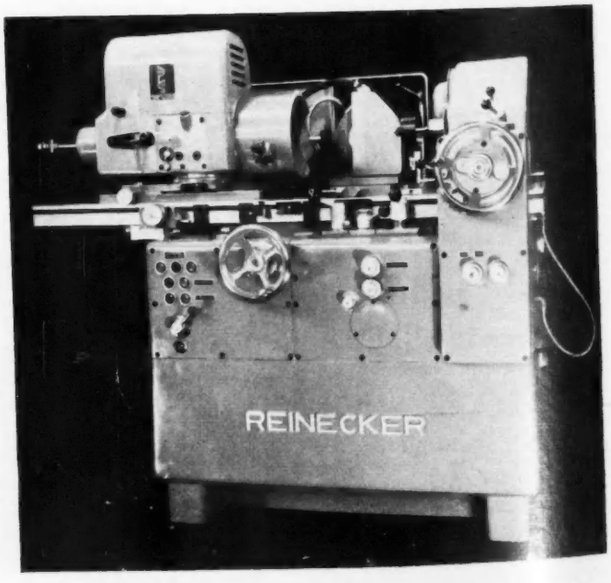


Fig. 12. Reinecker automatic internal grinder (Stuart Davis Ltd.).

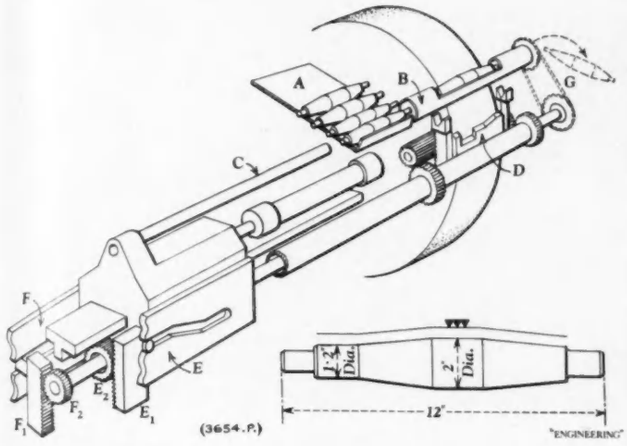


Fig. 13 Arrangement of Scrivener controlled-cycle centreless grinder with automatic feed and ejection, showing component for which machine is set.

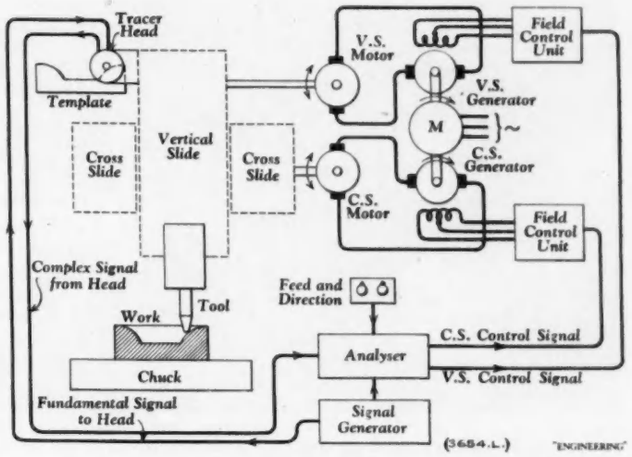


Fig. 15 Electronic profiling system developed by Lancashire Dynamo Electronic Products Ltd., as used with Webster and Bennett vertical mill.

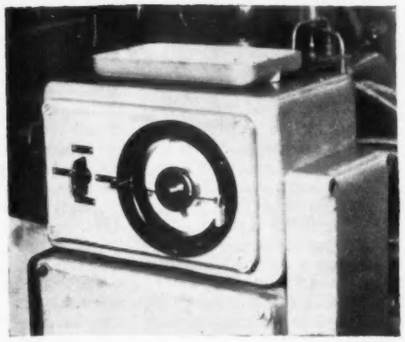


Fig. 14 Scrivener synchronous timing device which enables the final dwell or "sparking out" period in grinding operations to be adjusted from zero to 10 seconds.

inclined chute to a hook stop. The first piece is then gripped by spring-loaded transfer fingers, which contact the large-end diameter and under the action of a rack and pinion swing the piece over on to the plate. The piece is then released, ground and ejected. Scriveners are also demonstrating a push-feed mechanism, a roller-type through-feed unit and an automatic overhead loader.

An item which can be used to effect continuous automatic control of size on through-feed centreless work is the Scrivener micro-sizer. It is a device enabling the control wheel of a grinder to be advanced by a pre-determined distance varying from 0·0001 in. to 0·0005 in. and when used in conjunction with pneumatic ring gauging provides compensation for wheel wear and so permits continuous operation. Another unit, known as a synchronous timing device (Fig. 14), enables the final dwell or "sparking out" period to be adjusted from zero to 10 seconds.

The Scrivener No. 3 controlled-cycle centreless grinder can be set up to grind the stub-axle indicated in Fig. 13 with automatic feed and ejection. This is a heavy piece with two opposing tapers and two parallel diameters, so that the considerable difference in size between the large and small diameters would involve opening the wheels more than 1 in. on release to achieve a continuous throughput. The idle time would thus be unsatisfactorily long.

In the arrangement illustrated, the pieces are loaded on to the sloping magazine A, the bottom end of which is in line with the tubular guide B. At the commencement of the grinding cycle, the lowest piece is fed along this tube by the pusher rod C, which advances it a distance of some 16 in. to bring it into a position exactly over the formed workplate D. As the push-feed rod retracts, a pair of vertical lifting arms are raised; their upward movement is effected by the sliding cams E operating through the rack and pinion E_1 and E_2 on the outer of the two co-axial shafts. The simultaneous partial rotation of the tubular guide B, which places the workpiece in the V-pieces of the lifting arms, is obtained from a similar cam F, operating through its own rack and pinion F_1 and F_2, and the chain wheel and sprocket drive on the inner shaft at the rear of the grinding wheel. When the piece has been lowered on to the workplate, the controlled-cycle movement of the machine comes into operation: the control wheel (not shown) advances the piece on to the grinding wheel and withdraws after grinding has been completed.

On the commencement of the next cycle, the finish-ground piece is lifted back into the tube in the reverse manner to that previously described, so that the incoming piece pushes the finished component to the discharge end of the tube where, in a production line, a suitable multi-jet air-gauging station could conveniently be located.

PROFILING

Already a large number of profiling or copying systems are well known, but it may be worth noting here some recent additions in this field.

Webster and Bennett Profiling Mill.—A 48 in. single Series DH vertical boring and turning mill with built-in electronic profiling equipment is being shown by Webster and Bennett Limited, of Foleshill, Coventry. The operation of the electronic system, which has been developed by Lancashire Dynamo Electronic Products Limited, St. Stephen's House, London, S.W.1, is illustrated in Fig. 15. The direction of profiling and the feed is set. After initiation of a profile cycle the stylus (shown concentric with the tracer head) moves in towards the template. When the stylus contacts the template the output signal from the head, via the analyser, calls for a further increase in generator output and hence movement of the appropriate motorised slide. When the stylus deflection reaches a pre-determined figure, a relay is energised and the output of the other generator causes the appropriate motorised slide to move the stylus, hence the tool, tangential to the given profile. At this point, under profiling conditions, the complex signal from the head is analysed and split into two electrical signals equivalent to the mechanical displacements in the two axes. (It may be noted that the complex signal from the head represents the amplitude and direction of deflection of the stylus from its initially deflected position.) These two signals are compared with a reference. The two resultant signals provide the control signals for adjusting the cross and vertical slides according to the change in output from the tracer head. As the tracer head is rigidly coupled to the vertical slide carrying the tool a faithful reproduction of the template profile is produced on the work.

B.T.H. Tracing Head.—The British Thomson-Houston Company, Limited, of Rugby, have designed a wide range of electronic control equipment, which will be represented on their own stand and those of some 24 machine-tool manufacturers. It will include the automatic tracing head illustrated in Fig. 16, which will be demonstrated on a Giddings and Lewis 350 T horizontal milling and boring machine (stand of the Rockwell Machine Tool Company). This unit and its associated equipment offers complete three-dimensional tracing with automatic control of any combination of three feed motions. The machine will be shown cutting complicated press tools for motor-car bodies.

A novel tracing system, "Velvetrace," developed by Pratt and Whitney, U.S.A., in which the stylus does not touch the model but employs a short spark gap will be described later.

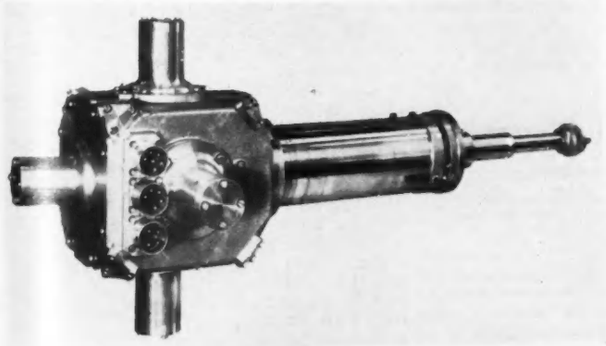
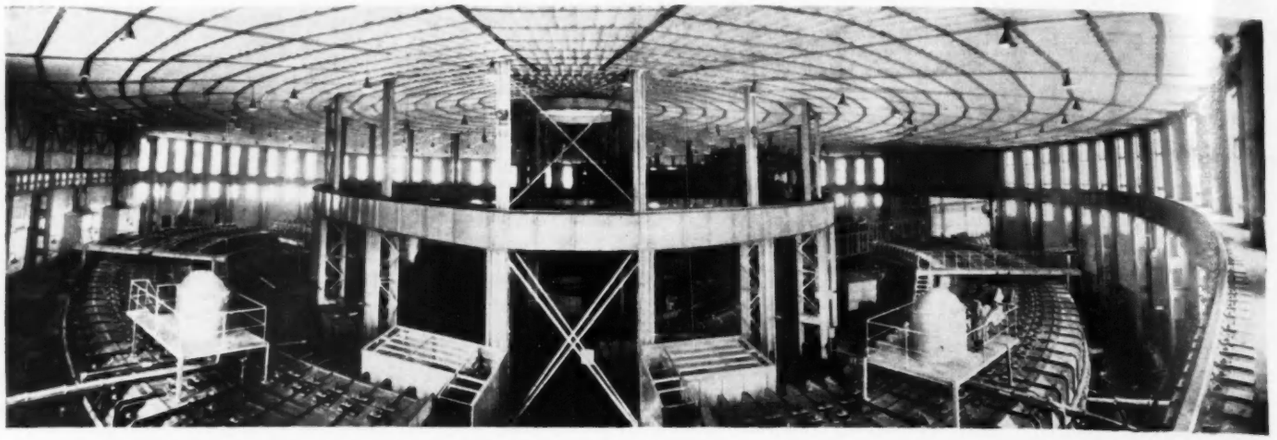


Fig. 16 British Thomson-Houston tracing head for three-dimensional electronic control of machine tools.



A 10 GeV proton synchroton now almost completed in the Soviet Union has a ring-shaped magnet containing 35,000 tons of steel.

ATOMIC REVIEW

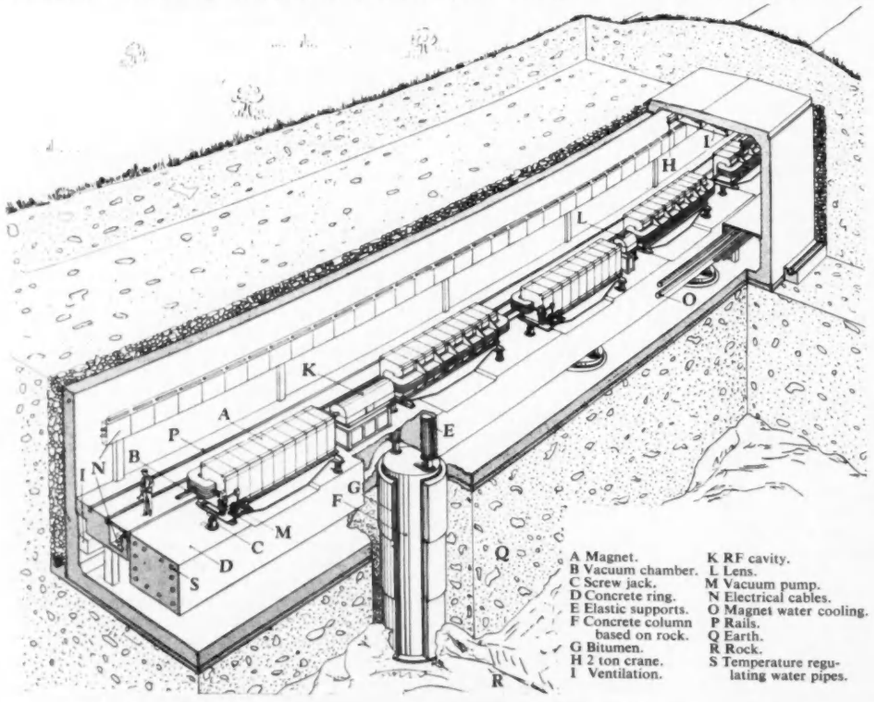
Tomorrow the Symposium on High Energy Physics held at Geneva by the European Organisation for Nuclear Research (CERN) comes to an end. In this article we shall report certain items discussed during the meeting and supplement our previous notes on that field of atomic study (ENGINEERING, *June* 1, *page* 444, 1956).

CERN Symposium

During the Symposium held by CERN at Geneva, the Soviet physicist, Professor V. I. Veksler, one of the three scientists who proposed the proton synchroton in its original form, described what is believed to be a new principle. He is reported as stating that inasmuch as a particle moving at a speed close to that of light emitted radiation in a forward direction, so energy could be transmitted to a particle by a reverse process. The source might be a separate group of fortuitous particles or radiation. Acceleration caused by the communication of energy in this way would be proportional to the number of particles accelerated and might therefore give very high energies, say 10 times greater than those effected by existing accelerators. Synchronising one process with another was not difficult, and the new method he denoted by the term "coherent," since it involved accelerating particles in a bunch.

Three approaches were discussed: one for acceleration to comparatively modest energies; another, believed capable of achieving very high energies if the bunch were small when interaction occurred, lay in the acceleration of a strongly ionised column of gas, known as plasma (see ENGINEERING, May 11, page 322, 1956); and a third involved acceleration by electro-magnetic waves. It is, of course, conceivable that these techniques may lead to the achievement of controlled thermonuclear fusion.

Another idea, though not entirely new, discussed at the Symposium dealt with the use of opposed particle beams. This system was described by workers of the United States Midwestern Universities Research Association, where a high-energy accelerator (referred to below) is projected. It was suggested that greater energies could be obtained by directing streams of particles at each other from two opposed accelerators, than by using a stationary target with one accelerator. It has been reported that two opposed 10 GeV machines might produce collision energies equivalent to a 250 GeV machine firing at a static target.



Section of ring, foundations and magnetic units of CERN 25 GeV proton synchroton.

Accelerators

Some further details have recently become available on the Soviet accelerator programme. In addition to a number of smaller accelerators in other places, there are two very large machines in the Institute for Nuclear Problems some 100 kilometres north of Moscow. One, a synchro-cyclotron with a 7,000 ton magnet, has been in operation since 1949. Its proton energy was increased from about 480 MeV to 680 MeV in 1953; it has pole pieces 6 metres in diameter and produces a mean internal proton current of 0·3 microampere. It is being used for nuclear research. The other machine is nearly complete, and should operate within a year. It is a 10 GeV proton synchroton, known in the Soviet Union as a "synchro-phasatron," with a ring-shaped magnet containing 35,000 tons of steel and is shown in the illustration above.

Two high-energy accelerators to be built in the United States not previously mentioned in these pages are those planned by the Midwestern Universities Research Association and by the Atomic Energy Commission's Argonne National Laboratory at Lemont, Illinois, operated by the University of Chicago. Physicists at the Midwestern universities have been engaged in a study of high-energy accelerators for the past two and a half years. One of the promising ideas developed by the group is known as the "fixed-field alternating gradient" principle, which they believe will permit the design of accelerators producing a larger number of high-energy particles than was hitherto possible.

Details of the CERN 25 GeV proton synchroton under construction at Meyrin in Switzerland are given in the Organisation's Annual Report (see ENGINEERING, June 15, page 506). It will consist of a ring some 220 yards in diameter, a section of which can be seen in the lower illustration and will be contained in a circular concrete tunnel. The main item is a vacuum tube of elliptical cross-section with major and minor axes of 6 in. and 3 in., through which the protons are accelerated during about 500,000 circuits by 100 magnet units, each weighing 32 tons. These magnets must be uniform in magnetic properties to an extremely high degree and dimensionally accurate. The particles are delivered to the circuit by an injection linear accelerator, in which the protons are accelerated to 500 keV by a cascade generator and then accelerated to 10 MeV in the first tank of a Linac vacuum system. Acceleration from 10 to 30 MeV, and from 30 to 50 MeV is provided in the next two tanks.

In Parliament

CONSULTATION ON AUTOMATION

In the House of Commons last week, the Prime Minister was urged by Mr. Ellis Smith (Labour) to set up an investigation into the effects of automation, on the same basis as the hearings on automation and technological change before the Sub-committee on Economic Stabilisation of the United States Congress Joint Committee on the Economic Report. Mr. Smith also asked Sir Anthony Eden if he would request British Ministers concerned with automation problems to consult together in a joint conference as soon as possible and to meet people well informed on the subject. Such action Mr. Smith suggested, would enable a policy to be prepared to meet the country's needs in this matter and to minimise any industrial friction that might arise.

Sir Anthony agreed that Britain could always learn from foreign countries but said that the Government felt that no time should be lost in putting to use what was already known about these processes. This course appeared to them to be better than having a formal investigation. The Ministers concerned would be discussing automation with their various advisory bodies. In particular, the Minister of Labour and National Service would shortly be meeting his National Joint Advisory Council, and information was being sought from the Engineering Advisory Council and other bodies connected with the engineering industry, regarding the probable adoption of new production techniques and the availability of the necessary special equipment.

SHORT TIME AGREEMENT

Mr. Smith asked Sir Anthony if he would draw the attention of the Ministers who were going to deal with automation matters to the evidence given by Mr. Walter P. Reuther before the Sub-committee of the United States Congress. It may be noted that Mr. Reuther, who is head of the United Automobile Workers of America and, since 1952, President of the Congress of Industrial Organisations, gave details to the Sub-committee on a number of aspects of the progress of automation in the automobile and engineering industries in the United States.

It was also pointed out to Sir Anthony that, according to clause 12 of the current national agreement between the engineering employers and the trade unions for the industry, systematic short time might be worked in preference to men being discharged. Mr. Smith suggested that, as British employees had made such a great contribution to the national welfare during the past 15 years of full employment, they should all have the opportunity of sharing in such employment as was available. Sir Anthony said that Ministers had indeed studied the report of the Sub-committee (*Automation and Technological Change: Hearings Before the Subcommittee on Economic Stabilisation*, Government Printing Office, Washington, price 2 dols.) and drew attention to its having been referred to in specific terms in the report of Department of Scientific and Industrial Research on automation.

TRADING BY ELECTRICITY BOARDS

Mr. Stephen McAdden (Conservative) inquired what action the Minister of Fuel and Power proposed to take regarding the recommendations of the Committee of Inquiry into the Electricity Supply Industry respecting the retail trading activities of the various area electricity boards.

In reply, Mr. Aubrey Jones said that he accepted the Committee's recommendations that it was to the best interests of consumers that the boards should continue to be free to participate in retail trading and contracting activities. At the same time, he considered it essential that competition between the boards and private traders in that field should be conducted fairly and he accepted in principle the Committee's recommendation that there should be a proper allocation of costs in the compilation of the boards' retail trading and contracting accounts. That did not mean that the boards should forgo the economies associated with large undertakings, but it did mean that the accounts should show as accurately as possible all overhead expenses properly chargeable to the business of retail trading and contracting. Mr. Jones said that he was in consultation with the industry about the manner of giving effect to this principle. No capital had been made available to the boards by him for hire purchase purposes this year.

SALES OF NUCLEAR POWER

Attention was drawn to the advertising programme of the Central Electricity Board and its area boards by Mr. G. Nabarro (Conservative), who asked the Minister what arrangements had been made in regard to promotional advertising by these bodies, including advertisements for nuclear power. Mr. Jones said he expected these boards, as responsible public bodies, to exercise reasonable restraint in their expenditure on advertising and to avoid forms of publicity which were misleading.

Within that general framework, the boards had full discretion, as commercial enterprises, to decide what forms of advertising had an economic justification and, Mr. Jones said, he could not undertake to regulate individual advertisements by them. It would be an impossible task, and it would undermine all sense of responsibility in these bodies for him to dictate to them in detail how they should conduct their affairs. He agreed that his attention had been directed to a series of advertisements in the *British Farmer* (the journal of the National Farmers' Union), advertising the sale of nuclear power to farmers in 1975.

IMPORTS OF MACHINE TOOLS

A number of amendments to the Finance Bill were debated and the Government's intention to suspend investment allowances, with certain exceptions, was one of the clauses which came up for criticism. One amendment, moved by Mr. Roy Jenkins (Labour) and seconded by Mr. Austen Albu (Labour), provided that capital expenditure up to £5,000 should continue to rank for the investment allowance and was intended to assist small businesses.

Another amendment was for the retention of investment allowances in the machine tool industry. Mr. C. R. Hobson (Labour), who moved it, pointed out that, although this industry was not faced with a decline in orders, it was vital to the nation's economy as the prime mover of the engineering industry. It was essential that the machine tool industry should retain the benefit of the allowance at this time, when it was facing increased foreign competition. The seconder, Mr. Albu, said that, as the basic industry for every manufacturing activity in this country, its expansion was quite inadequate. In the first two months of this year, imports of machine tools had exceeded exports. Steel and capital goods had been imported last year for the manufacture of consumer goods.

The Economic Secretary to the Treasury, Sir Edward Boyle, Bt., agreed that the importation of machine tools early this year had been disturbing but investment in the steel industry during 1956 was expected to reach £63 million. The Chancellor of the Exchequer had carefully considered this amendment, for which there was a strong case. He had come to the conclusion, however, that exceptional treatment should be given to shipping, scientific research, and fuel saving, and that that was as far as he could go this year. Dollar imports of machine tools were still fairly rigidly controlled. Both amendments were subsequently defeated.

Silencers for Jet Engines

The work of the research department of the Ministry of Supply on the diminution of noise from aircraft was referred to by Mr. A. E. Hunter (Labour). He drew the Minister's attention to the success which had been achieved by the new silencer pen fitted to a Javelin jet fighter aircraft and asked what progress was being made in connection with airliners ordered by the Department. Mr. Reginald Maudling replied that it was hoped to have available towards the end of next year a silencer for engines running on the ground which would be suitable for the larger type of jet airliners. Noise reduction in flight was a more complex problem and the final answer to that problem had not yet been found. Work on various kinds of jet nozzles gave promise of effecting an appreciable reduction in noise and that work was continuing. It was hoped to have a silencer available for large jet airliners before these aircraft came into regular operation.

Transport of Coal

The Minister of Fuel and Power, Mr. Aubrey Jones, declined to give a general direction to the National Coal Board not to use road haulage for the transport of coal, where facilities for its transport by rail or waterway were available. He informed Mr. William N. Warbey (Labour) that collieries were, in fact, laid out to move the bulk of their output by rail. Facilities for loading road vehicles were limited and, where they were available, their use was, in the last resort, for the buyer to determine.

Electricity Generation by Atomic Energy

Mr. Warbey asked the Lord Privy Seal for information as to the main components of the price of 0·6 pence per kilowatt hour which the United Kingdom Atomic Energy Authority estimated to be the total net cost of electricity generated by the early nuclear power stations. He also inquired as to what selling price had been assumed for the plutonium by-product for the purpose of that estimate. Mr. R. A. Butler replied that the detailed figures on which the estimate was based had been given in one of the papers presented to the Geneva conference on atomic energy last August. Although some of the figures used in building up the estimate referred to had altered, in one way or the other, the estimate remained the best that could be given.

Foreign Workers for Coalmining

Some particulars about the number of men from overseas now working in the coalmining industry were given by Mr. Robert Carr, the Parliamentary Secretary to the Ministry of Labour and National Service. He told Sir Charles S. Taylor (Conservative) that it was understood from the National Coal Board that there were about 10,300 foreign employees in its coalmining labour force, including 5,300 Poles, 3,800 European volunteer workers and 750 Italians. The Board was unable to take advantage of the Ministry's standing arrangements for the recruitment of further foreign workers in the absence of agreement with the National Union of Mineworkers.

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NOTICES OF MEETINGS

British Productivity Council

LONDON
All-Day Discussion on "Productivity and the Production Worker." Organised by the North London Productivity Committee. Tottenham Central Library, 391 High-road, London, N.17. Thursday, July 5, 10 a.m. to 5.30 p.m. (Registration fee 5s.)

Building Centre

LONDON
Various documentary films. Wed., June 27, 12.45 p.m.

Manchester Joint Research Council

MANCHESTER
Address on "Automation," by the Earl of Halsbury. Whitworth Hall, The University, Manchester. Mon., July 9, 2.15 p.m. (Admission by ticket.)

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

British Productivity Council. Apply to Mr. Charles Cooper, 126 The Ridgeway, Enfield. (HOWard 2611.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Manchester Joint Research Council, Chamber of Commerce, Ship Canal House, King-street, Manchester 2. (Deansgate 5574.)

THE HUMAN ELEMENT

Shipyard specialists give more trouble—A proper but distasteful decision—Skill does pay—Cost of a good example—The degree of government control of wages—The storm continues around automation.

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More on Drilling Holes

A second dispute has broken out over the drilling of holes on the refrigerated cargo liner "Calamares" at Cammell Laird's Birkenhead shipyard. This time the dispute concerns who should fix metal straps to plastic panels. The drillers were given the job, and 150 joiners sat down and refused to work. They subsequently agreed to go back on the advice of their district official but refused to carry out any further work on the job in question until an arbitration tribunal was invoked. Meantime the 700 joiners in the yard have put a ban on overtime, as well as threatened a strike if the company do not suspend work as requested. The Amalgamated Society of Woodworkers have taken a surprisingly firm line on the matter, so soon after the settlement of the original dispute. The Shipwrights and Ship Contractors Association, to which the drillers belong, assert that it is their job to drill holes in the metal base.

So it goes on. Small wonder that Mr. W. White, president of the American Pan-Ore Steamship Company made some scathing remarks about Cammell Laird and the British shipbuilding industry in general. Mr. White said that the earlier strike has cost his company 500,000 dols. in lost earnings and that he had decided not to ask for British bids for new ships. This has cost the industry the opportunity of competing for £6·4 million of shipbuilding orders. The Managing Director of Cammell Laird, Mr. R. W. Johnson, in commenting upon what he called the "very heartrending remarks" of Mr. White, said: "we are trying to be as tolerant as we can, and we can only hope that all those who are fighting for the various jobs at stake, and bringing into use new materials and methods, can solve their problems with the help of responsible heads of unions." A hope to which most people would subscribe.

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Guilt by Association?

The dismissal of Mr. John Lang by Imperial Chemical Industries Limited because he is considered by the Government to be a bad security risk for I.C.I.'s work on certain official contracts has aroused a good deal of public discussion. Quite rightly, people's prejudices are on the side of Mr. Lang. In a matter of this kind, the public is left to make what it can of half of the truth and it is quite reasonable that the other half should not be made public property for reasons of security. The half truth available does not completely support the prejudices.

I.C.I. have made it quite clear that they have dispensed with Mr. Lang's services because they could not retain them and get certain Government work. The obligations and duties of a public company under these circumstances are clear and I.C.I. has fulfilled them. This company's concern for the terms of employment of its staff is well known and their decision must have been a hard one. Their hand was forced. Had it not been so, they would presumably have considered him employable, an issue first raised for them on his behalf in 1951. For his own part, Mr. Lang has not been quick to see the writing on the wall. He must have been aware that he was running a growing risk. It is of interest that Mr. Herbert Morrison, a member of the Privy Council committee recently inquiring into this question in general terms, has counselled caution on taking the matter further.

Mr. Lang and his employers have been caught in the trammels of the security machine, and it is in the public interest that as much of the truth as possible should have public debate. The price of liberty is still eternal vigilance. Distasteful decisions have had to be taken. That done, their execution should be carried out as generously as possible.

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Youth and the Mining Engineer

In his presidential address to the Association of Mining Electrical and Mechanical Engineers earlier this month, Mr. J. D. Morton took as his subject "Youth and the Mining Electrical and Mechanical Engineer." Pointing out the appalling waste of youngsters which came out of the Great Depression in the 1930's, when men never had a chance to show what they could make of their apprenticeship training in the mines, he makes a striking contrast with the situation to-day. In the present conditions of the labour market, the difficulty is to make youth realise the advantages which will accrue in the long run to the man who has a skill and that some day he will really gain over the unskilled man, who has possibly occupied a series of temporarily, at least, lucrative dead-end jobs.

This, Mr. Morton realises, is no small assignment. The great bulk of young people are not remarkable for their forward-looking propensities. The wage packet of to-day rates higher than the problematic higher skilled pay of tomorrow. The pressure of trade union negotiation is, of course, all in favour of the short-term view.

Mr. Morton draws attention to the efforts which have been made within the coal industry, so far not with conspicuous success, to reduce the training period of promising youths and get them into responsible positions as soon as possible. There is much to be said for this approach. Many apprenticeship periods are unconscionably long, so as to protect the market of the journeyman and to suit the convenience of the skilled men. It is very much open to question if such thinking is to be condoned in a time of full employment.

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M.P.s' Salaries

The Prime Minister is being tough on the members of the House of Commons. Last week he rejected out of hand a request made jointly by Mr. Gaitskell and Mr. Clement-Davies, for an independent committee of enquiry to advise on the remuneration of M.P.s At a time when the Government are calling for restraint in wages and salary demands he could hardly have done otherwise: it would be wrong for Ministers and M.P.s "who are rightly expected to set an example," to raise their own remuneration now. Mr. Eden's letter expressed sympathy with the desire, which is understood to be widespread, to have salaries and allowances raised substantially: ". . . we fully realise the financial difficulties facing a number of members of Parliament on both sides of the House. In particular, the junior Ministers in the Government, who by reason of their appointment are unable to take any part in professional or business activities, are heavily handicapped.". He then proceeded to reject the recommendations of a select committee of the House who had reported on the matter.

There is now strong resentment against the Government's policy, which is said to favour the well-to-do Conservatives. Mr. Gaitskell may well be forced, by the pressure of his backbenchers, to take action and force a debate. In such an event it will be particularly galling for those Tories who have not the good fortune of a private income or another job, to vote themselves out of a rise. It is indeed questionable whether the Government are right in pursuing this policy of no rise at any price. An M.P.'s duties and responsibilities are as important as they are onerous. It can hardly be in the nation's interest to have underpaid representatives at Westminster, or to have a House full of half-timers.

Wages in Nationalised Industries

There is a growing belief that the Government are losing votes through their failure to arrest the wage-price spiral, and pressure is increasing to have a "freeze" of both wages and prices in nationalised industries. This comes at a time when the Government are reconsidering their policy towards these industries. The crucial issue is whether the Government, through the Ministers and Departments concerned, should interfere with the commercial policy of the nationalised Boards, or should allow them to act as independent bodies responsible for their own decisions.

Already there are sharp differences in the practice of some Ministers. Mr. Aubrey Jones allows the fuel and power industries to run their own affairs. Mr. Watkinson takes a great deal upon himself in directing the policy of the transport industries. But to issue an edict saying that in future all wage negotiations relating to employees in the nationalised industries would have to be conducted with the Government would probably carry more dangers than advantages. Sooner or later a union would defy the official ruling, and there would be a strike against a political body. The outcome of such a strike could result in a serious lowering of the Government's prestige if successful, or to political bitterness on the part of trade union members if broken. It would not avoid pay claims and strikes but would make each issue so major that the whole country would be affected. Another aspect of increased Government control is the inevitable shifting of responsibility from the people who run an industry to people who who administer the nation's affairs. The loss of prestige by the Boards could not mean effective and responsible running of the day-to-day business.

There is little likelihood of the Government taking such a course. Once followed it must lead to complete control of the whole economy, and this is hardly one of the aims of the present Government. A more likely course is the development of a national wages policy, through advice, persuasion and encouragement. Whatever the urgency of the need, in a democracy there can be no substitute for collective bargaining. There is a strong case against this being between unions and Government: if it were, arbitration courts would still have the last word.

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Automation—the Eternal Debate

The storm of debate about automation on the shores of industrial relations still goes on. The hope is surely that it will blow itself out ere long and take most of the problem with it. At the moment it is producing a good deal of shoddy and tiresome intellectual driftwood. The outstanding feature of the storm, however, is the amount of wind.

The president of the National Union of Vehicle Builders has let it be known that the unions will be united if automation leads to a struggle with management. The president of the Amalgamated Union of Operative Bakers, Confectioners and Allied Workers has referred to the subject in terms of a production crisis for capitalism. Such outbursts make an unfavourable contrast with the recent intelligent approach to the problem by the T.U.C.

A number of industrialists have now come forward to stress the inevitability of automation, including Sir Godfrey Ince, now chairman of Cable and Wireless and formerly Permanent Secretary at the Ministry of Labour. There still seems to be a widespread doubt on the side of labour whether they can get effective consultation with management ahead of the installation of automotive controls, and the secretary of the National Union of Bank Employees has recently expressed scepticism about this. Meanwhile, however, Briggs Motor Bodies have issued a booklet to their shop stewards setting out their plans for automation in the future. This all looks like the inevitability of gradualness—of the noisier sort.

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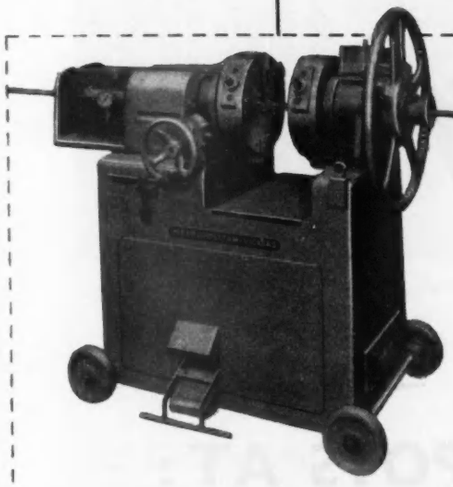

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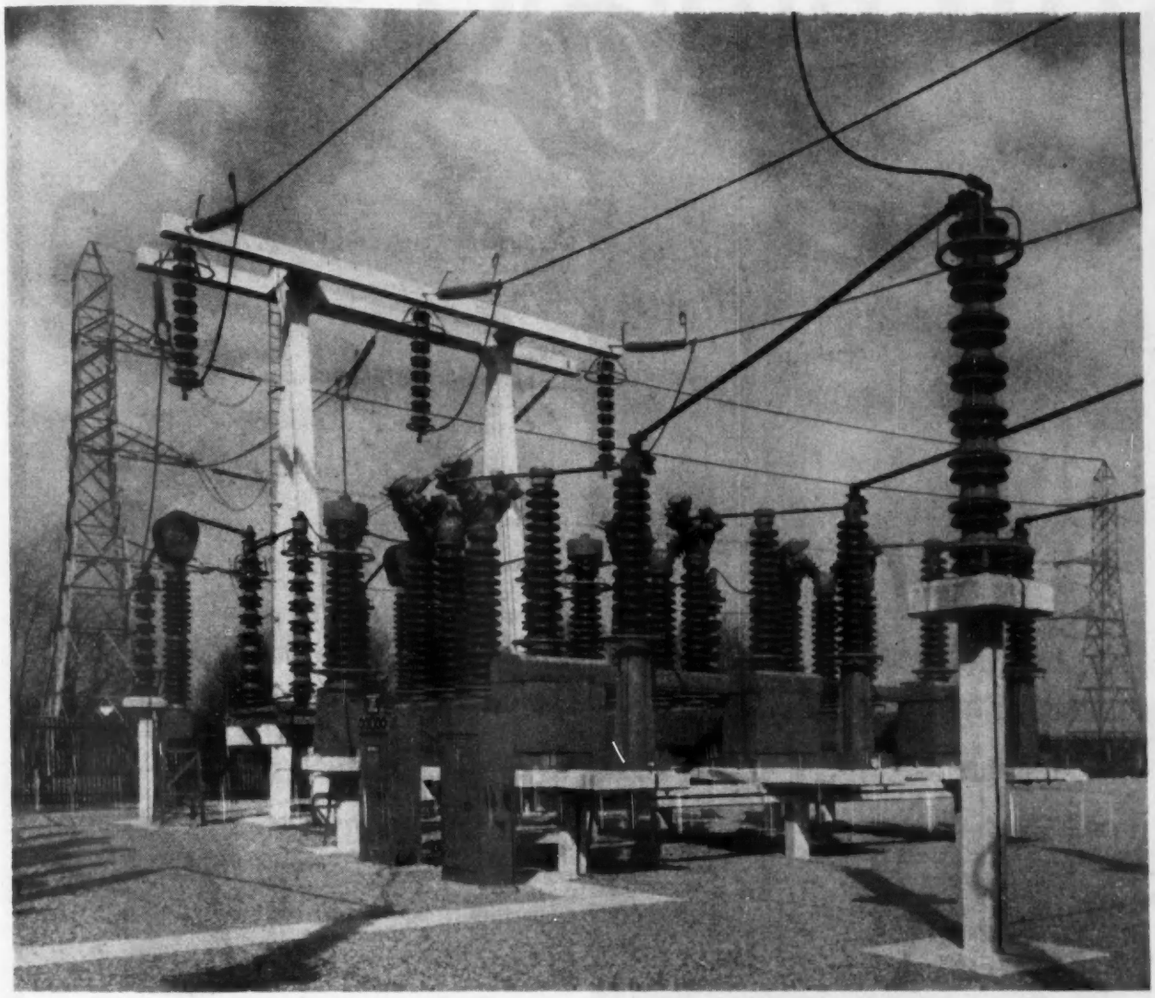

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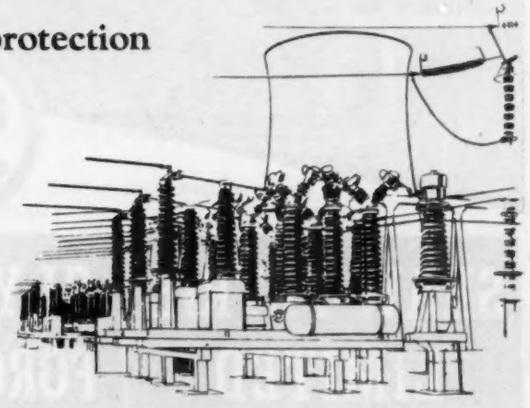

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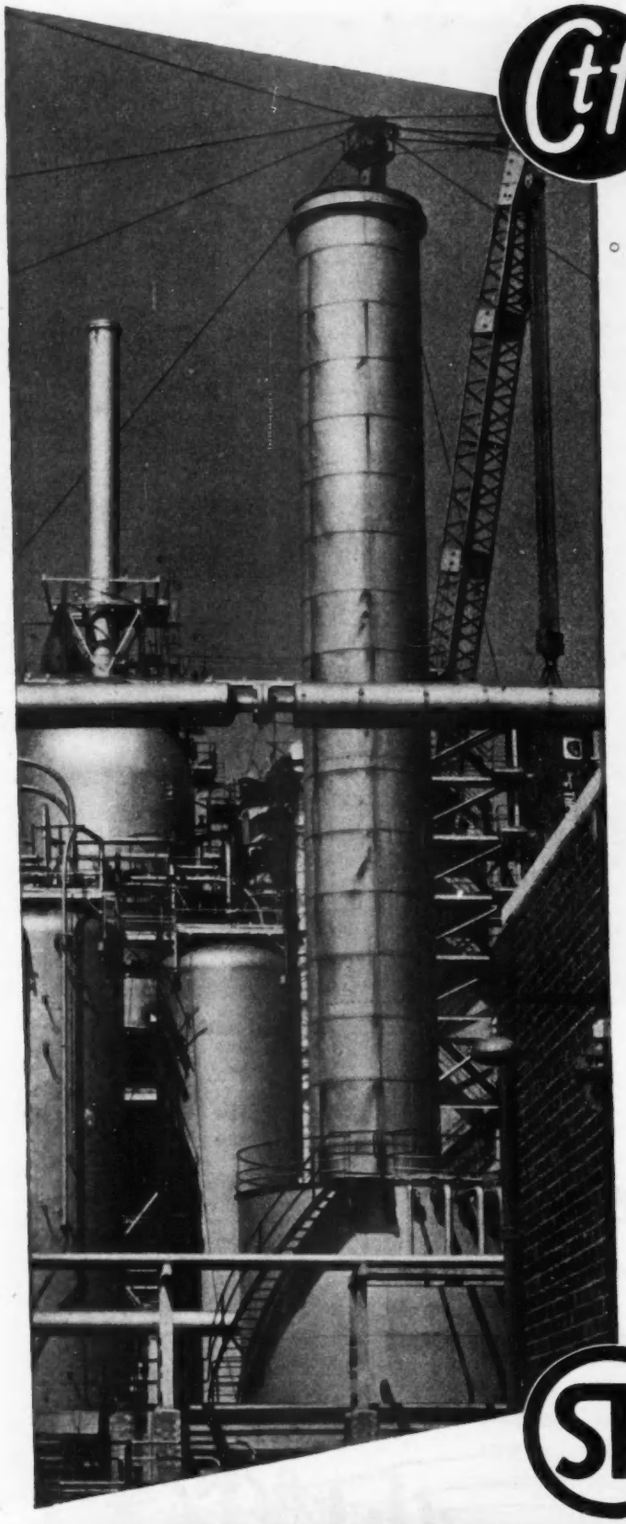

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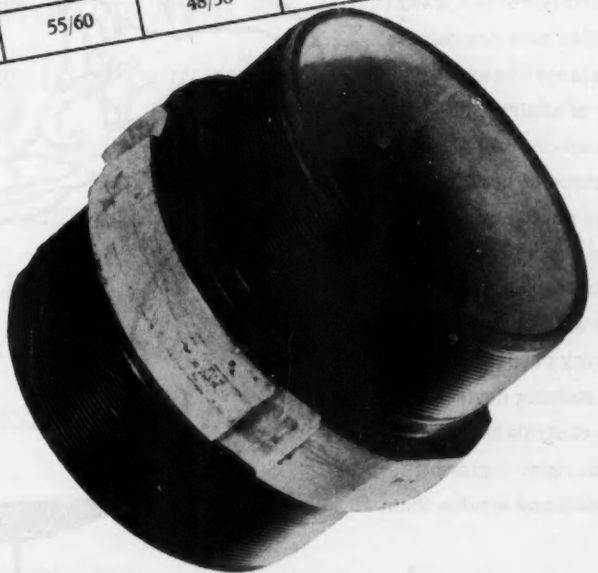

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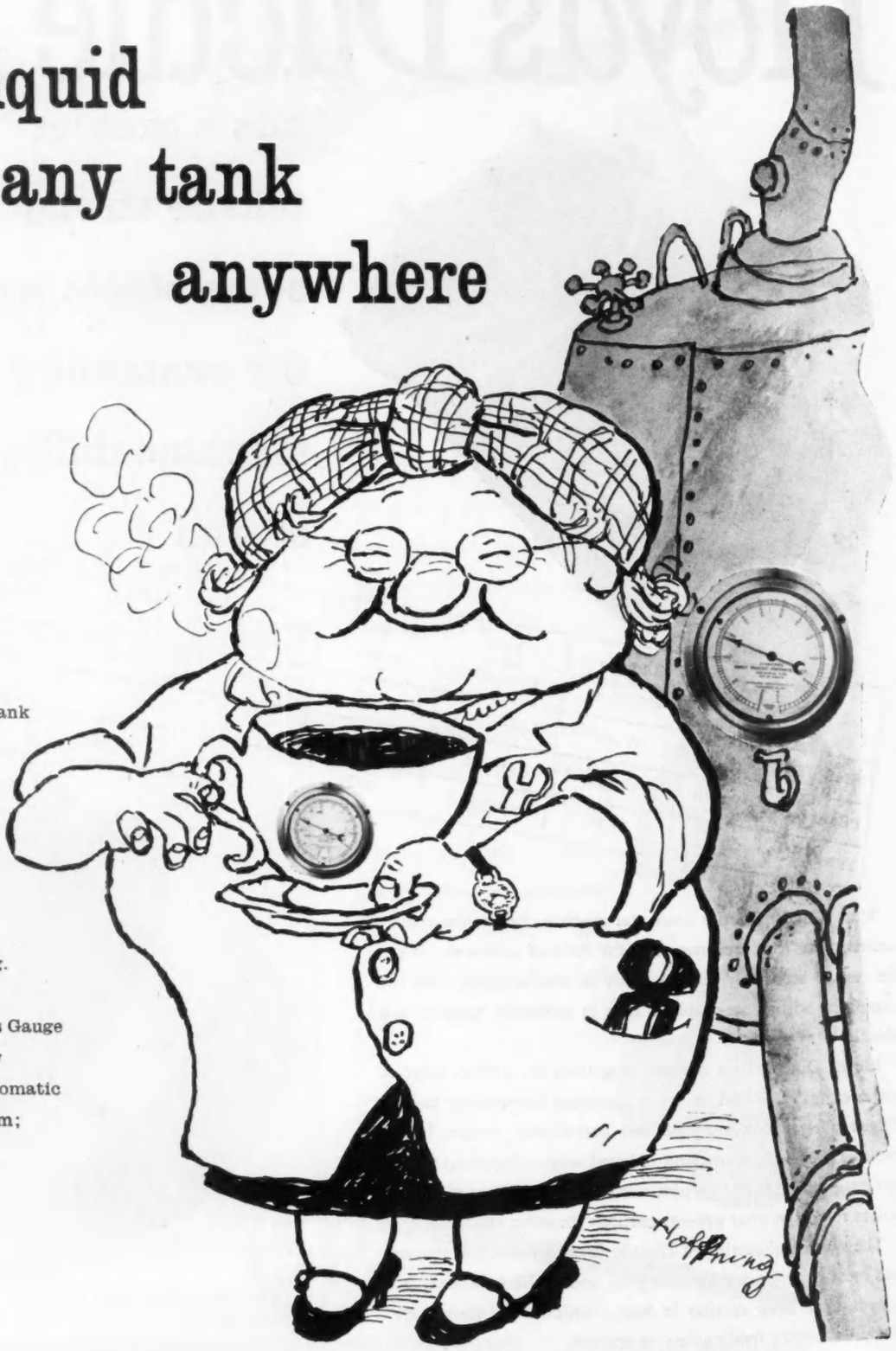

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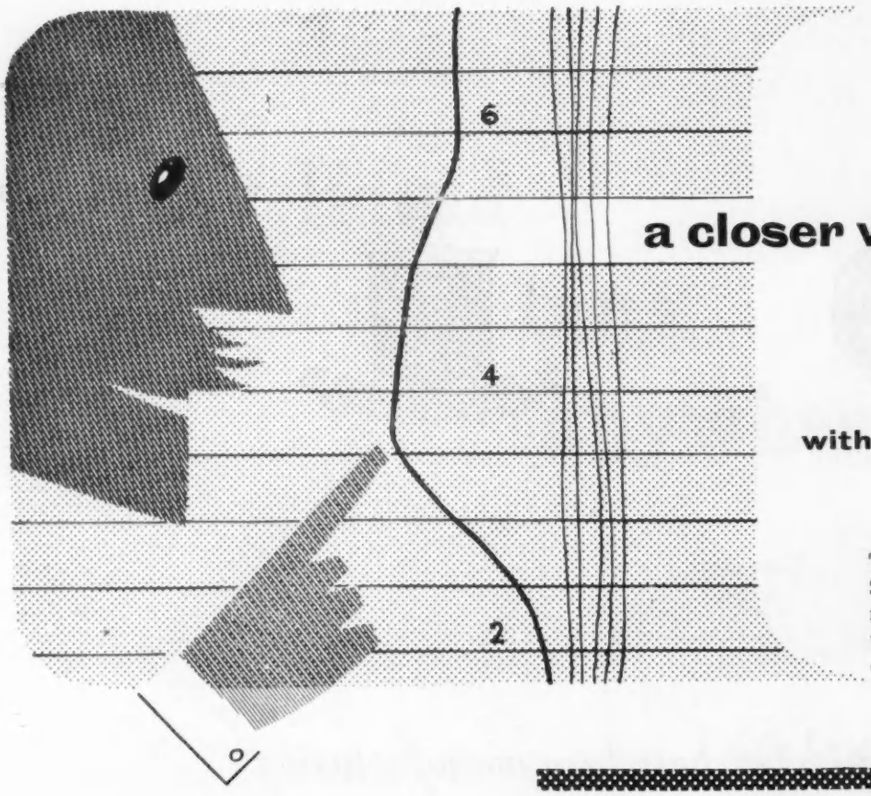

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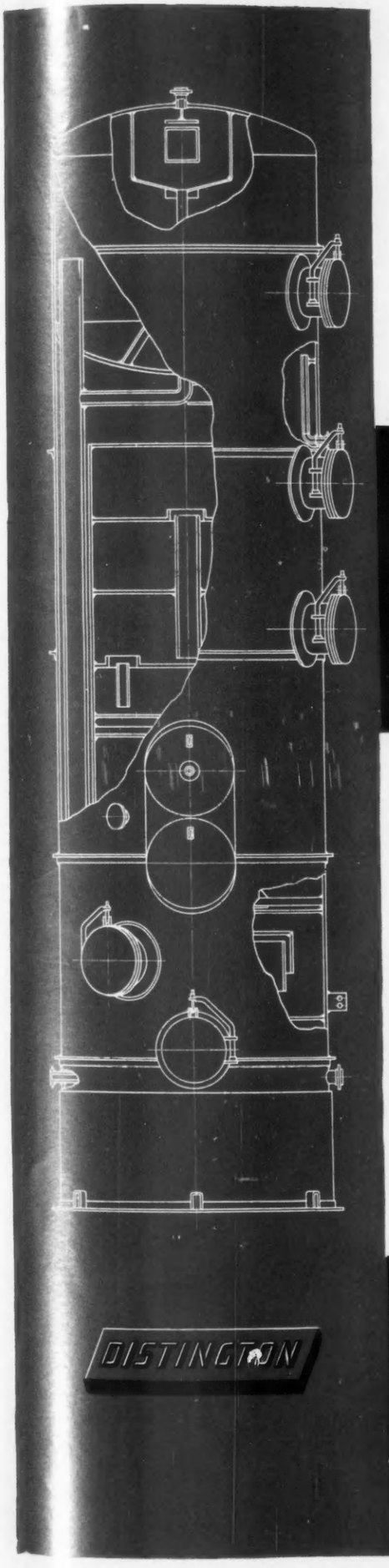

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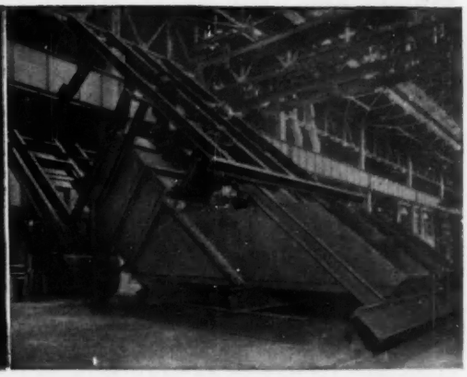

(*above left*) Draught tube cones produced for The English Electric Company Limited, and used in an important hydro-electric installation overseas.

(*above right*) Ore loading pocket with lining plates of 12% manganese steel. The pocket was dismantled, and re-assembled at a mine overseas.

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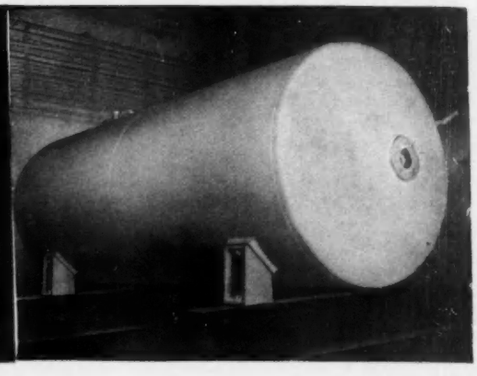

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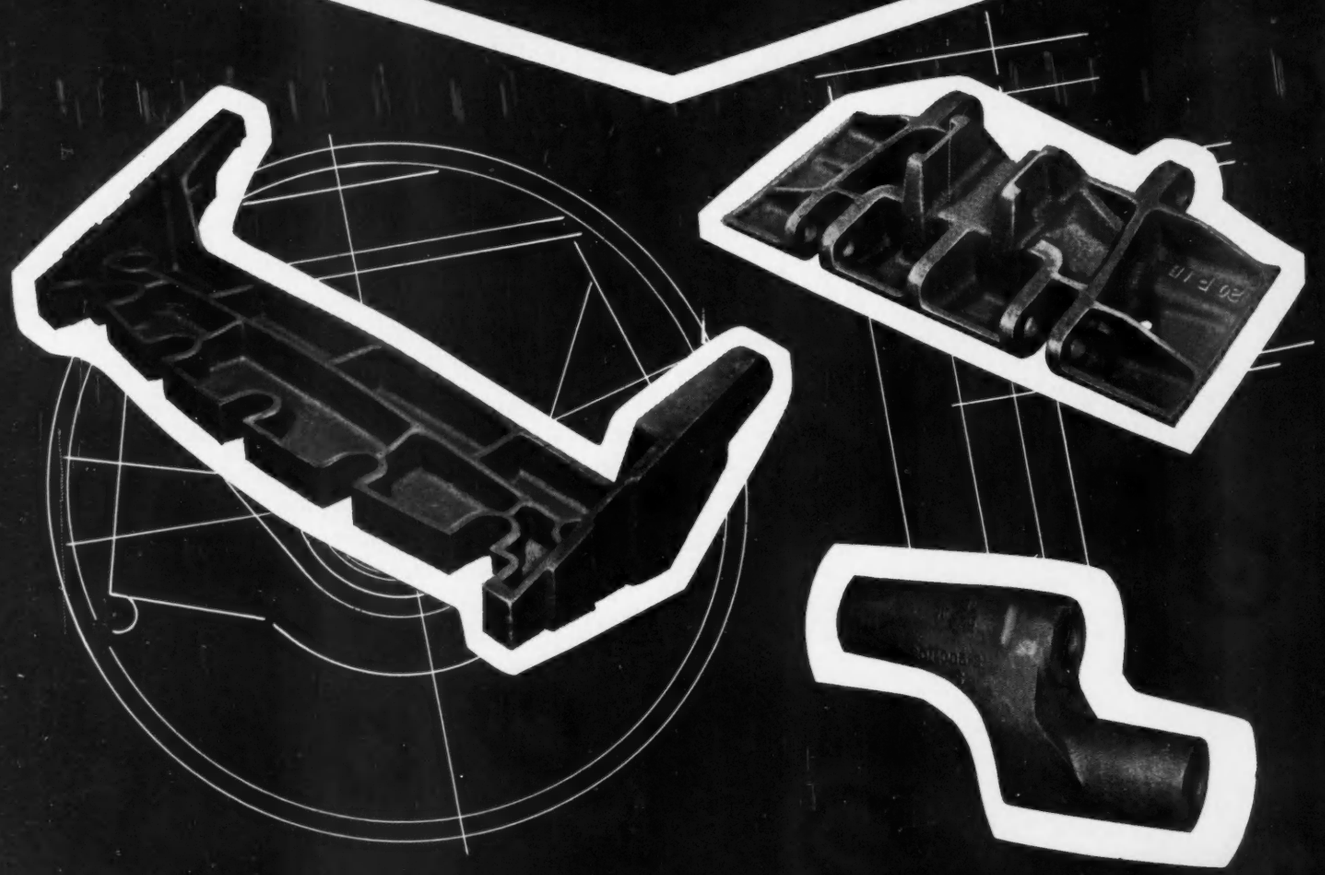

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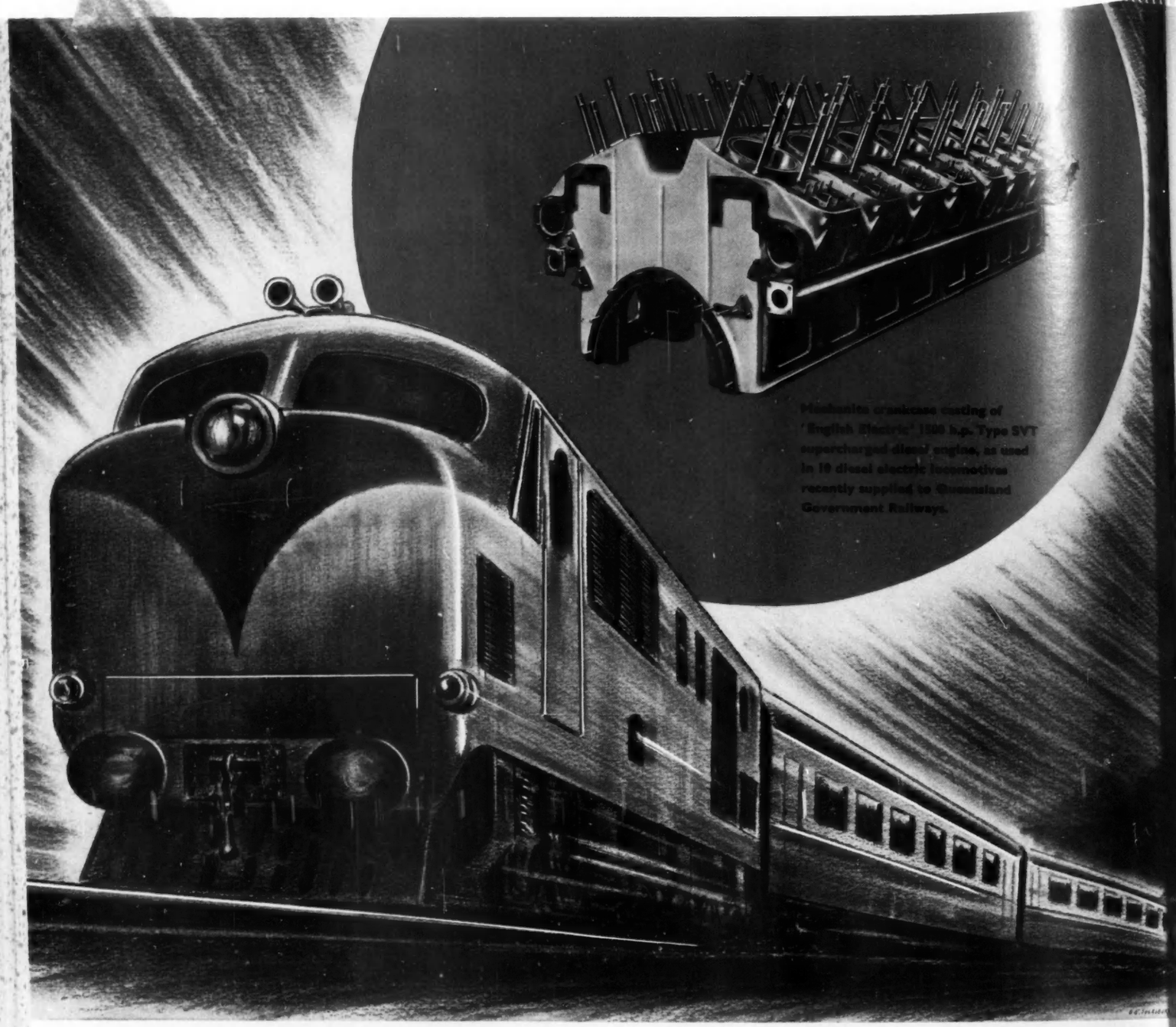

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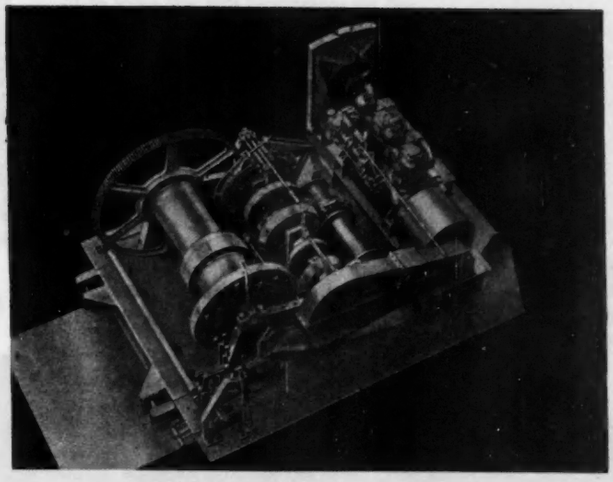

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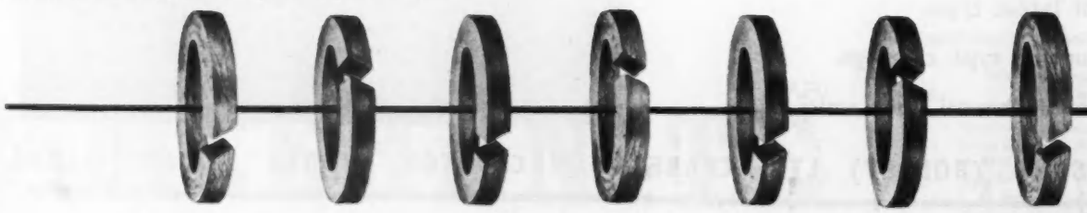

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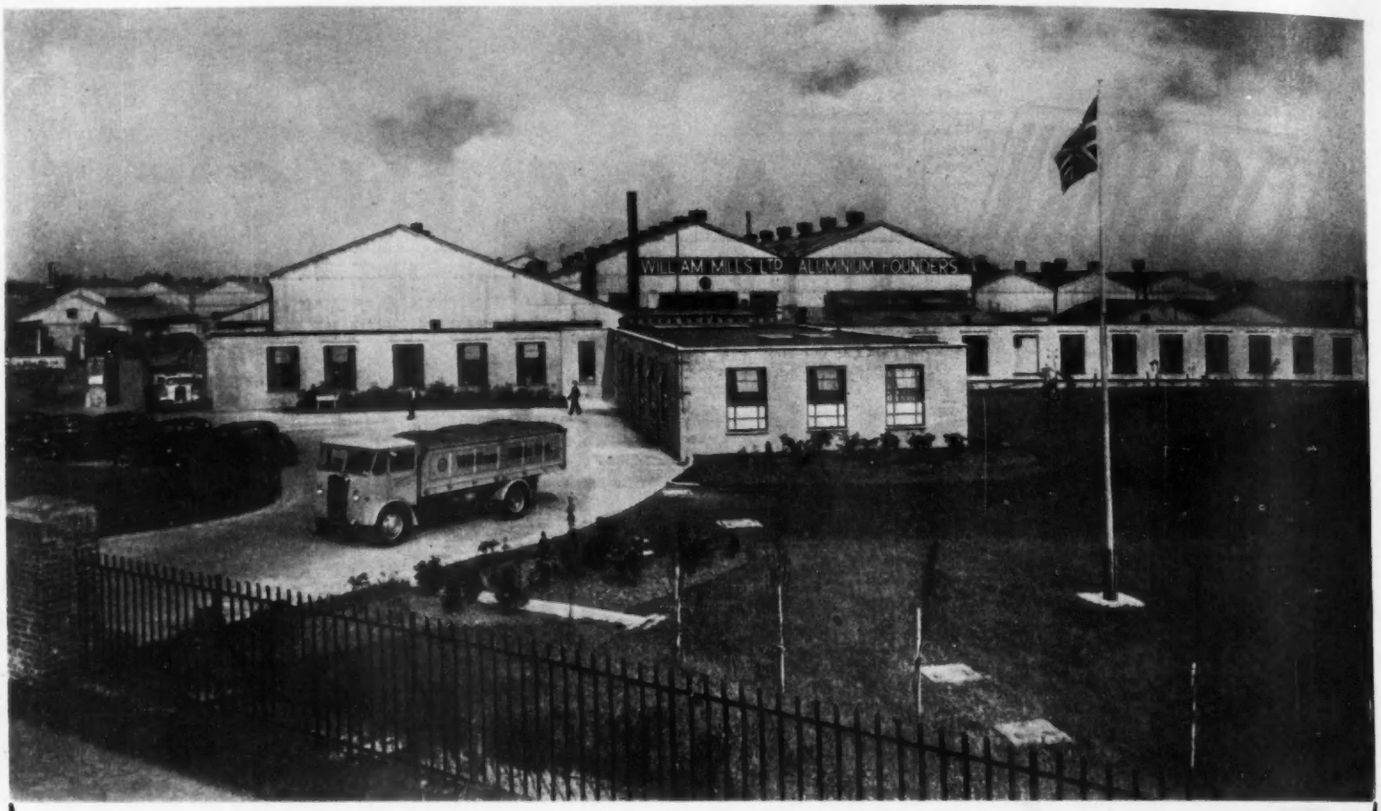

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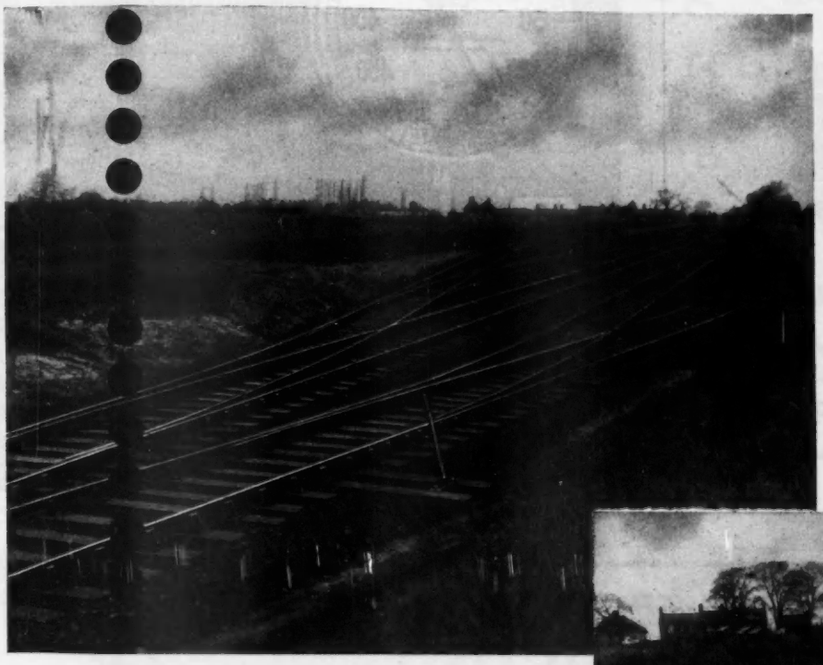

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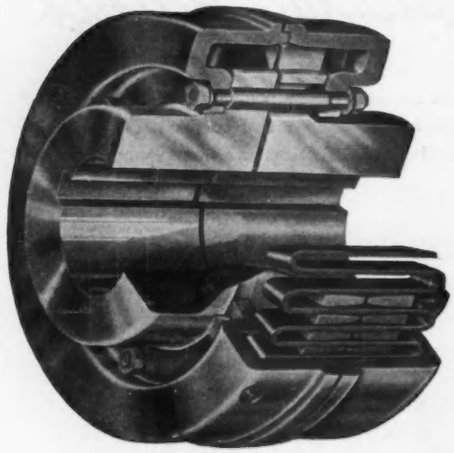

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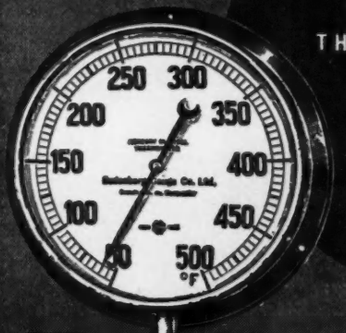

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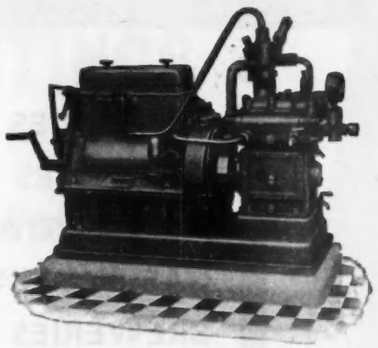
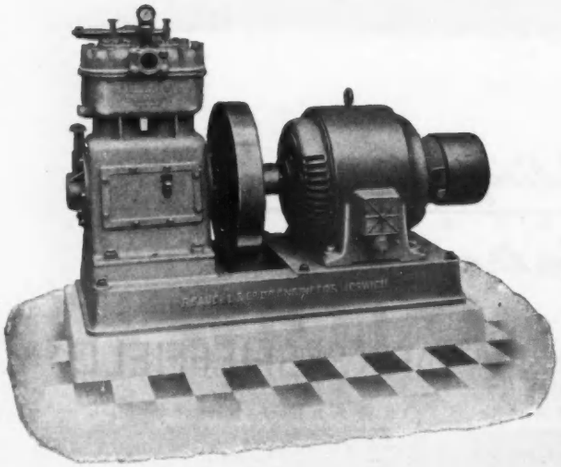
VERTICAL SINGLE-ACTING TYPE.

Two-stage compressors similar to that illustrated on the right are made in three types for pressures up to 450, 600 and 1000 lbs. per square inch. They are belt driven or direct coupled to electric-motors, petrol or Diesel Engines.





Single-stage compressors similar to that shown on the left are suitable for pressures up to 100 lbs. per square inch. They are made with one, two or three cylinders, according to the capacity required, and are driven in the same way as the machines above.

For full information write, giving particulars of the duty required, to Department "B."

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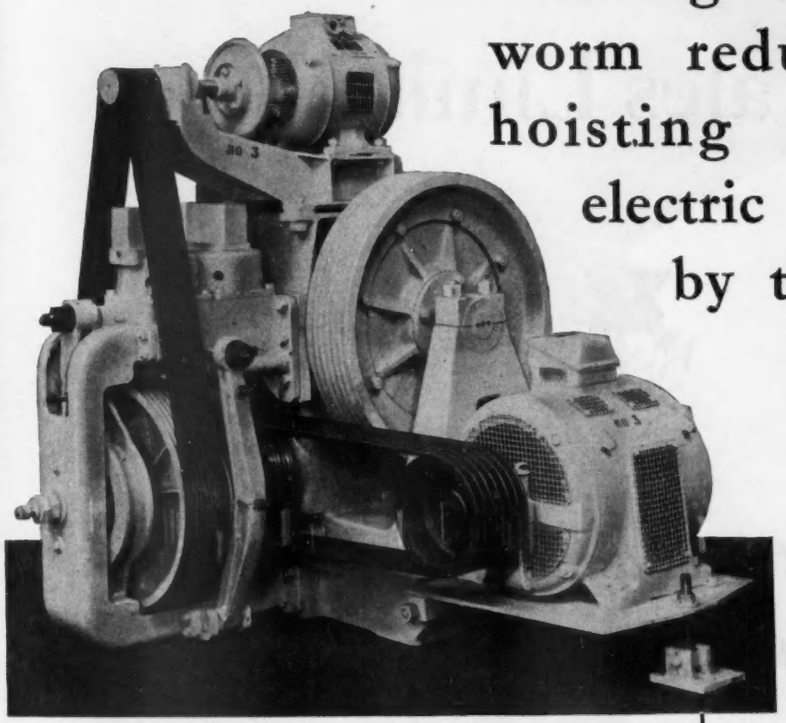

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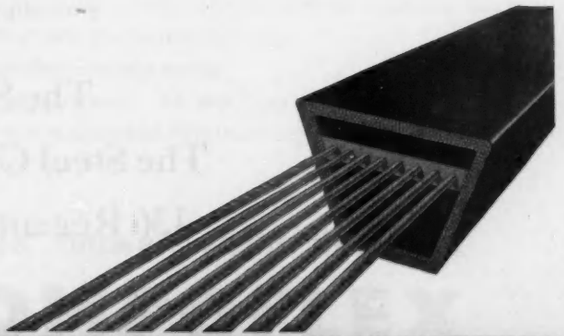

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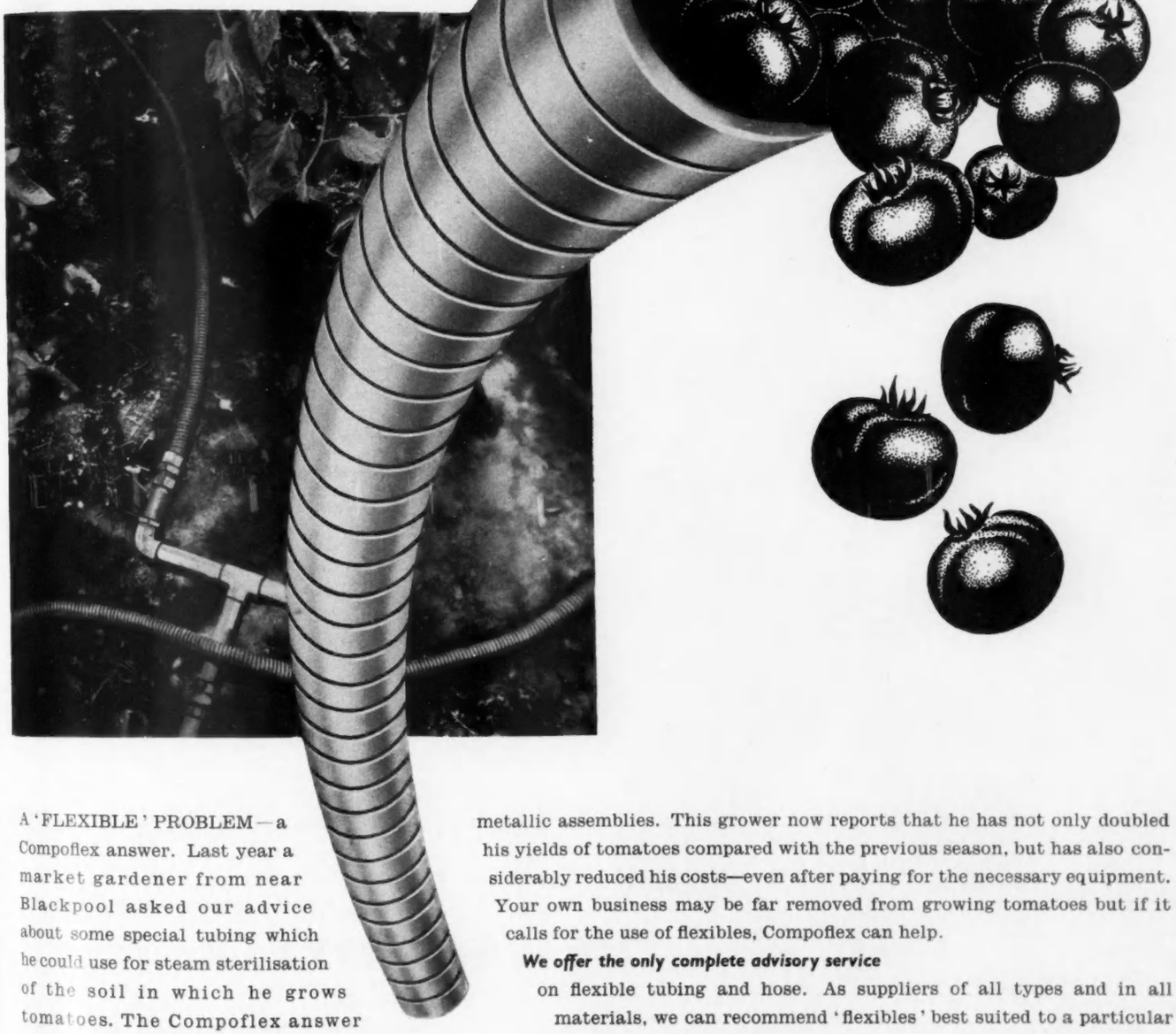

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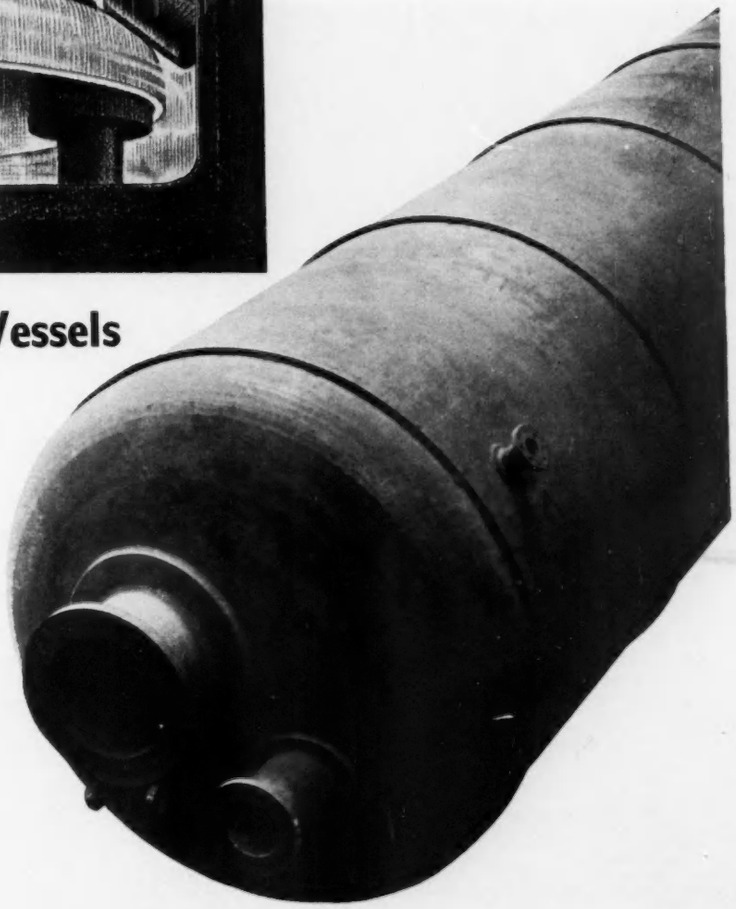

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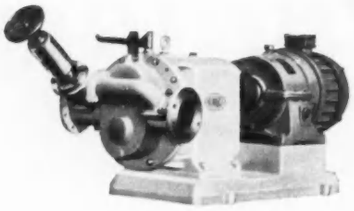

For pumping heavy viscous liquids, and sensitive fluids when violent agitation would be harmful the Howard 'M' type Easy Cleaning Rotary Pump is ideal. Made in seven sizes for capacities from 100—20,000 GPH manufactured in stainless steel and other corrosion resistant alloys, jacketed pump casing if required.

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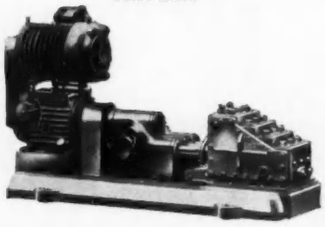

For those services requiring an "even flow" against high pressures the Howard Triplex Pump is available in three sizes, 5, 10, 20 HP with wide choice of liquid ends giving outputs up to 6,000 GPH and pressures of 12,000 p.s.i. jacketed liquid ends supplied, also double check valves if required.

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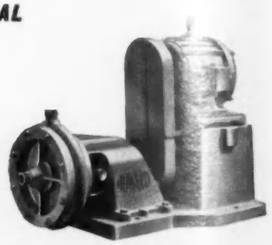

Available in two designs—the normal type with closed impellors and flanged connections for chemical industry, and the easy-clean type with open impellor and all internal parts smooth machined, specially for the Food and Dairy Industries. Both types have circular casings permitting outputs from 5—300 GPM for heads up to 140 p.s.i. can be supplied if required with mechanical gland seals also jacketed casings when called for.

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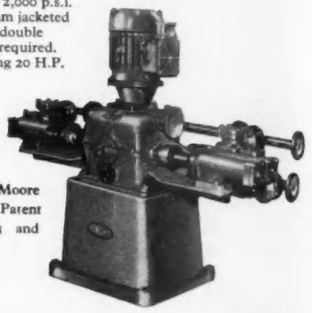

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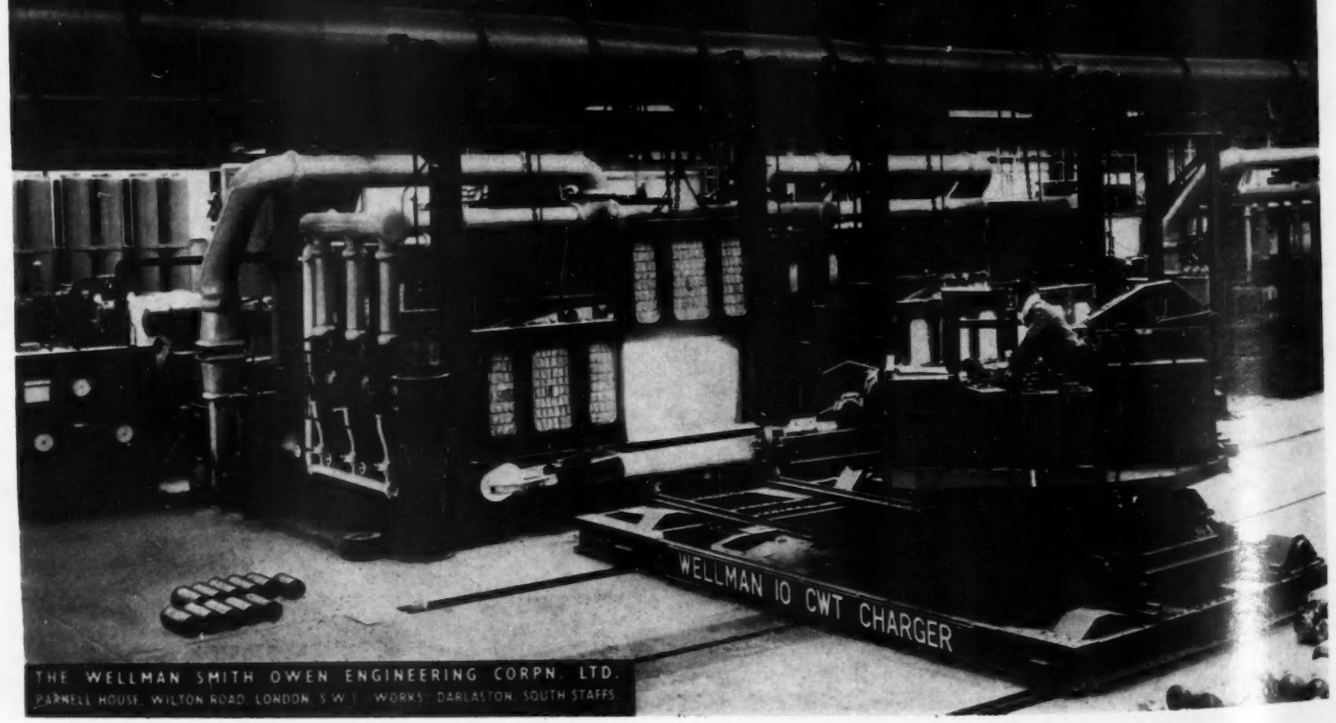

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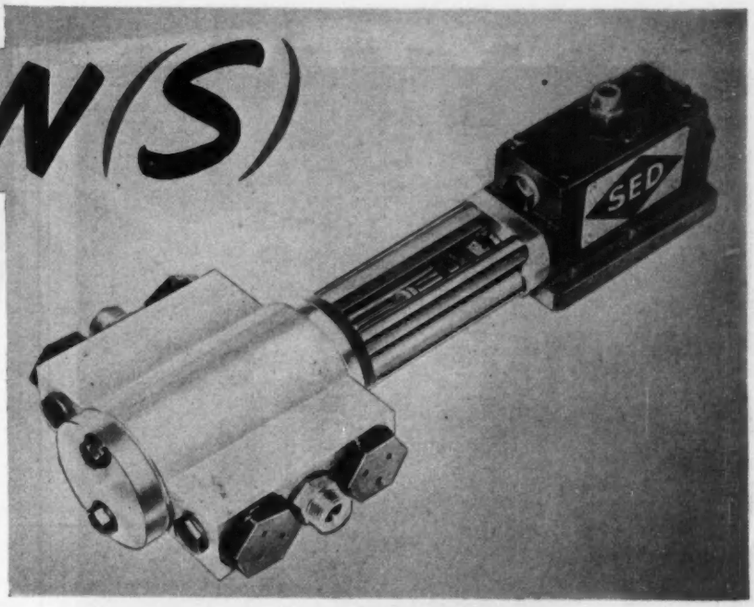

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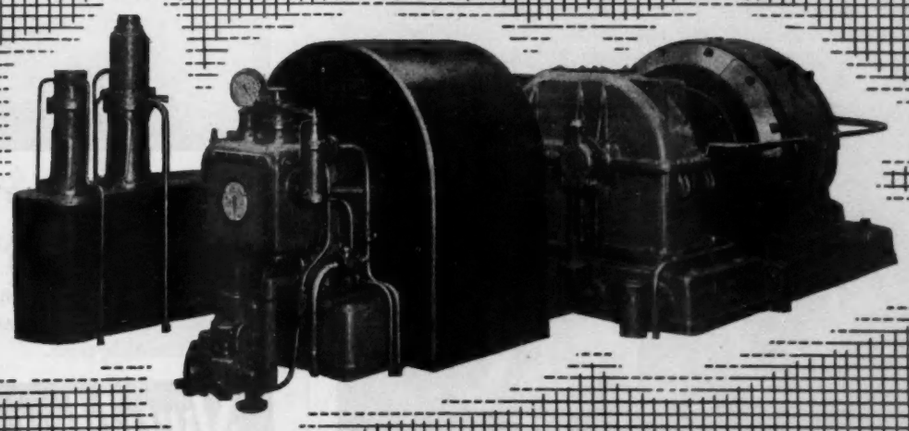

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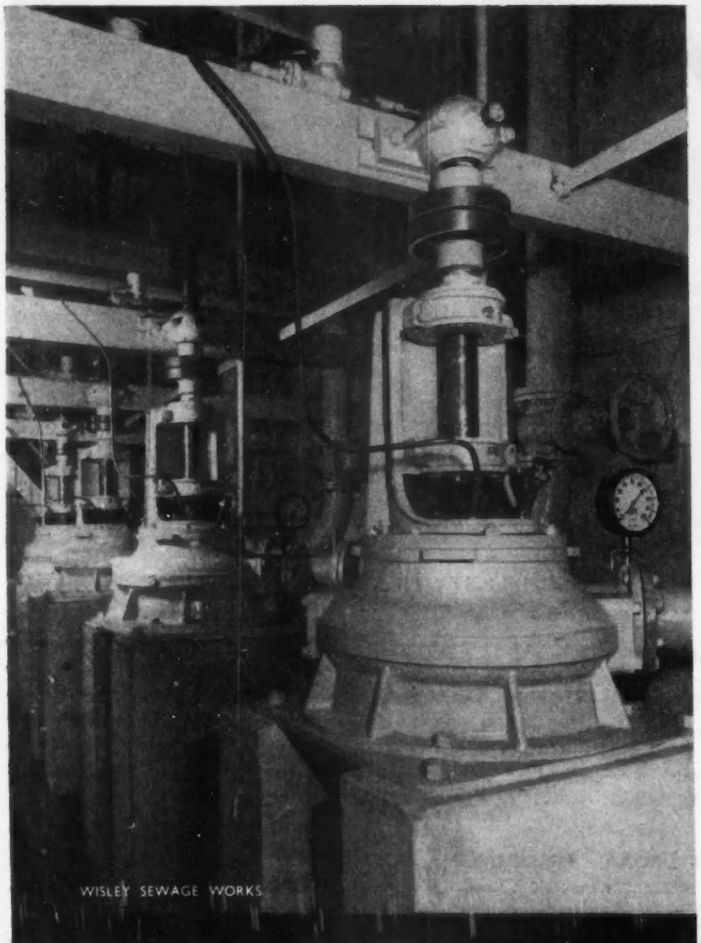

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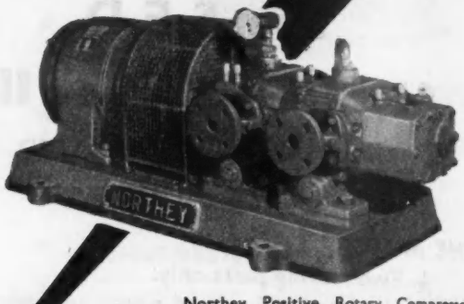

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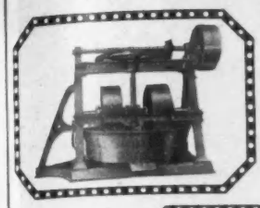

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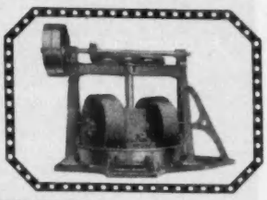

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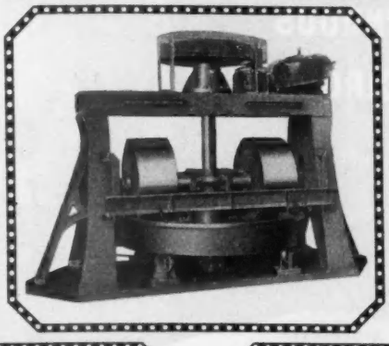

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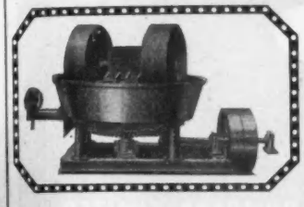

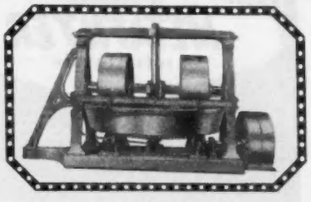

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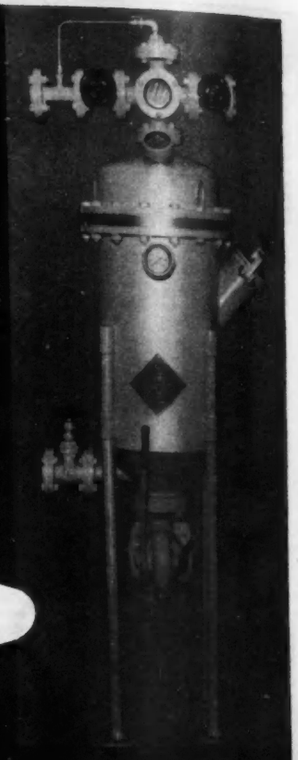

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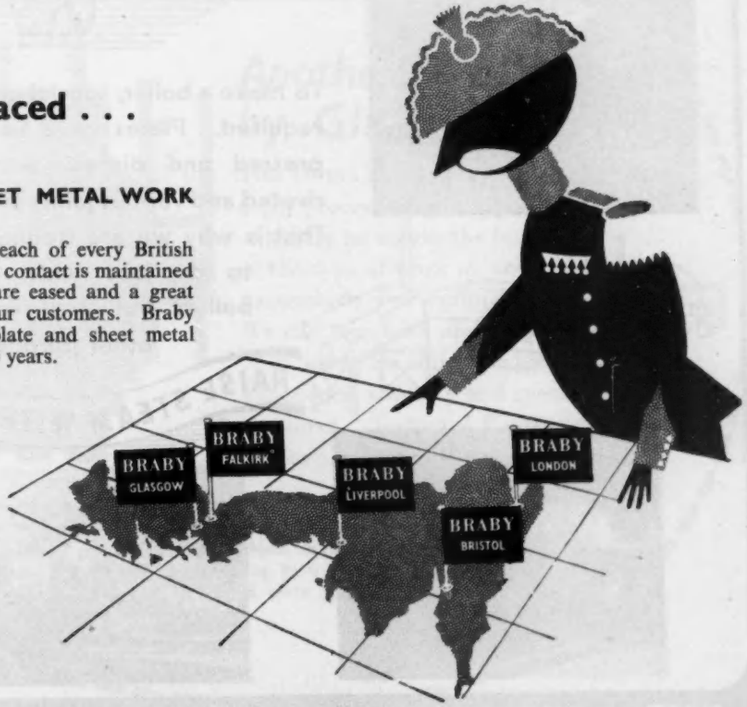

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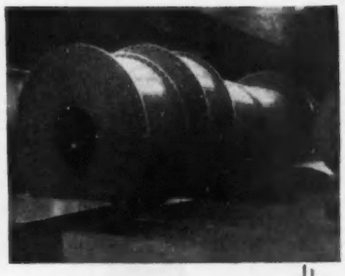
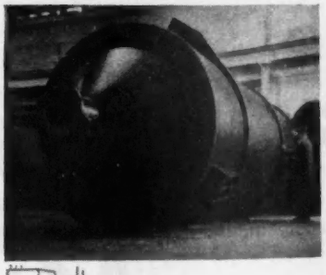
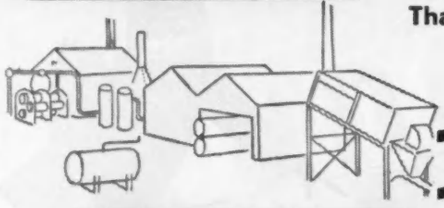
FARRAR BOILERS

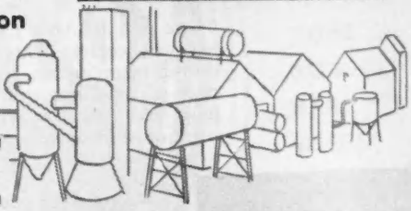
TRADE MARK



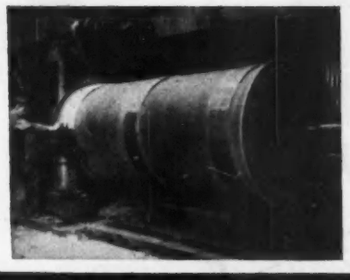


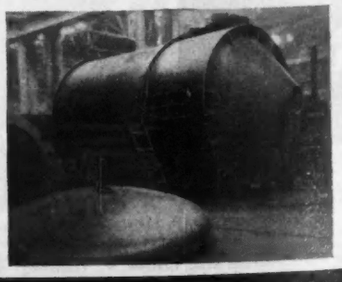
To make a boiler, special plant and tools are required. Plates have to be rolled, ends pressed and dished, seams hydraulically riveted and various joints electrically welded. That is why we are frequently called upon to do jobs which look like boilers but are required for other purposes.





RAISE STEAM WITH A "FARRAR"





THE FARRAR BOILERWORKS LTD. NEWARK (Notts) ENGLAND

TELEGRAMS: FARRAR NEWARK 1143 ★ ★ ★ ★ ★ ★ ★ ★ TELEPHONES: NEWARK 1143-4-5

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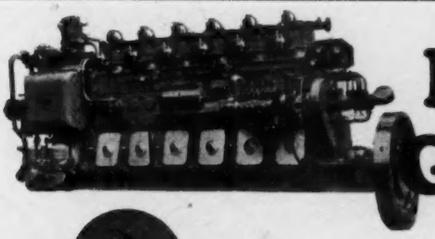

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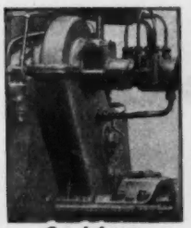

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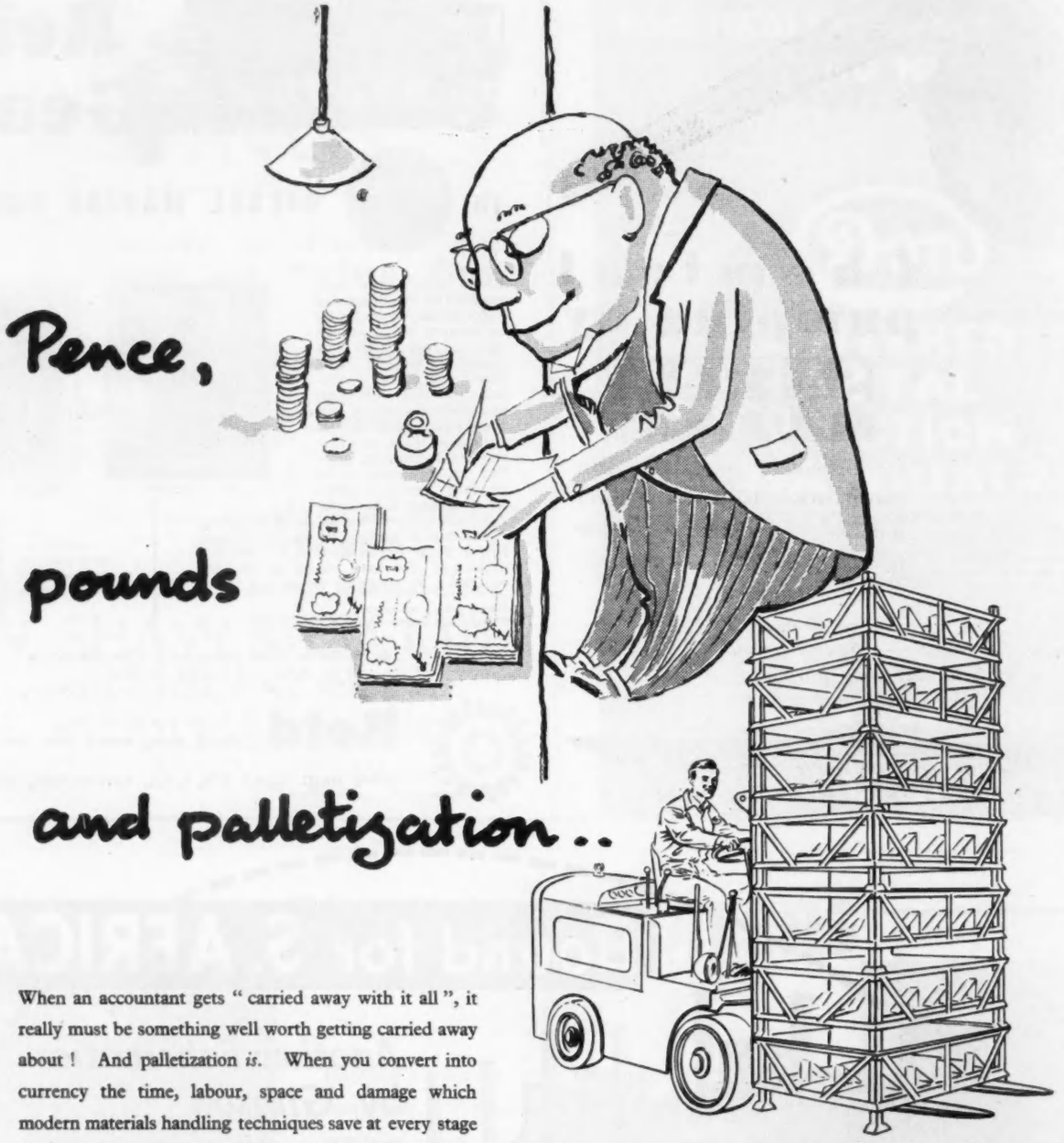

When an accountant gets " carried away with it all ", it really must be something well worth getting carried away about ! And palletization *is*. When you convert into currency the time, labour, space and damage which modern materials handling techniques save at every stage from raw materials to customer, the figures amount to such stuff as dreams are made of. Dreams of reducing overall costs, increasing profit margins, streamlining production. . .

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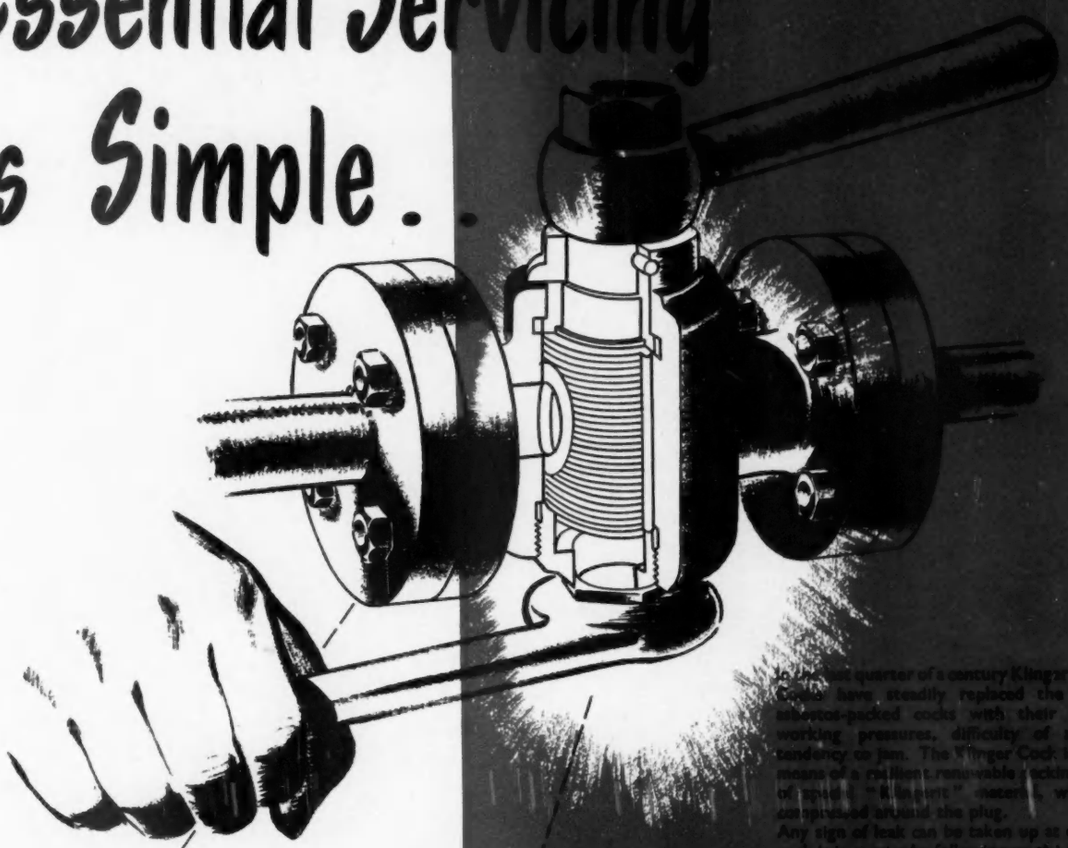

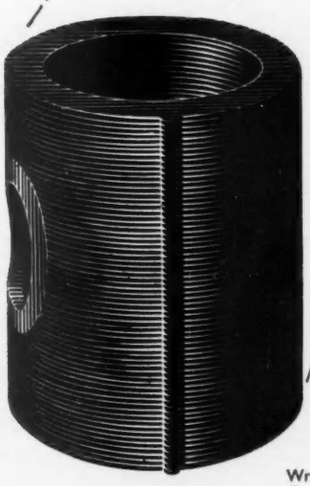

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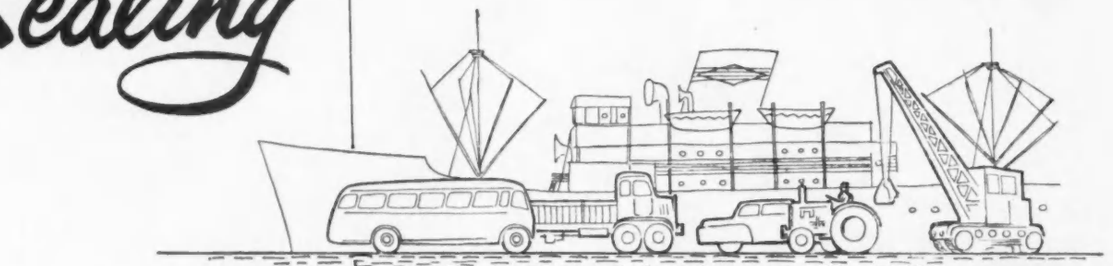

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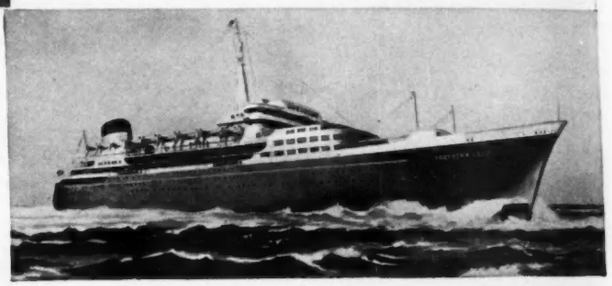

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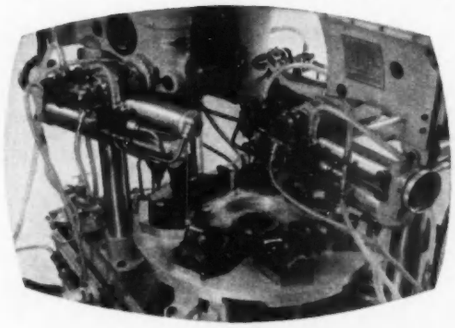
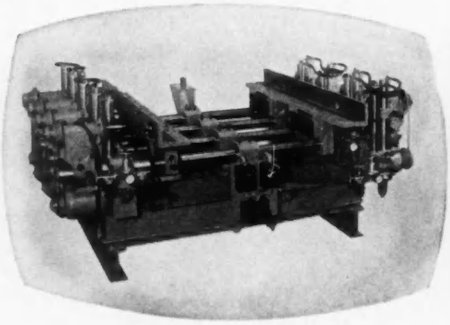
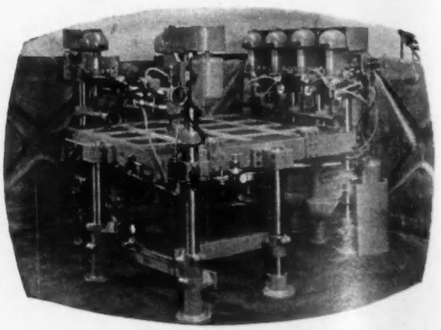
means automation by compressed air. And it means production up and costs down! Some examples of AIRMATION are shown where MAXAM control valves, cylinders etc. are used for moving, clamping and sequence control on special purpose machines designed and made by PACERA (W. J. Meddings Ltd.), by whose kind permission the illustrations appear. Can our Technical Staff help you with AIRMATION?







● *Right:* A machine for drilling 16 holes in a 64 in. x 82 in. component. 8 heads at 12 in. centres operate simultaneously. Component is automatically moved to next station and the operation repeated, leaving 16 holes at 6 in. centres. Floor to floor time 47 seconds; previously, the operation required 16 mins. 10 secs.

● *Centre:* Progressive drilling followed by tapping on a specia' Hammer Head. Three operations performed simultaneously and in sequence with automatic table indexing. Floor to floor time 33 seconds; previously, the operation required 18 mins. 18 secs.

● *Left:* A machine for drilling 18 holes in a 64 in. x 82 in. component. Firstly 8 heads directly opposed at 12 in. centres operate simultaneously. The component is rotated through 90 deg. when 10 heads operate to complete. Floor to floor time 47 seconds; previously, the operation required 15 mins. 10 secs.

TAS/CK-597

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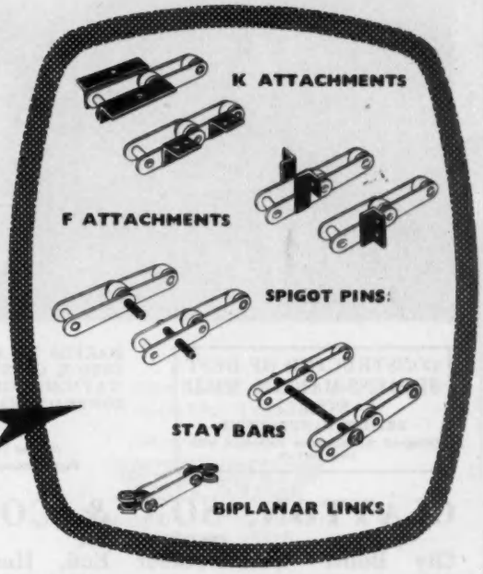

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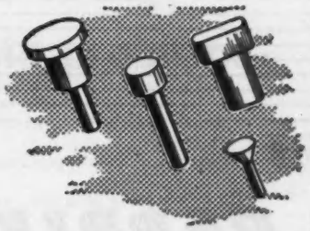

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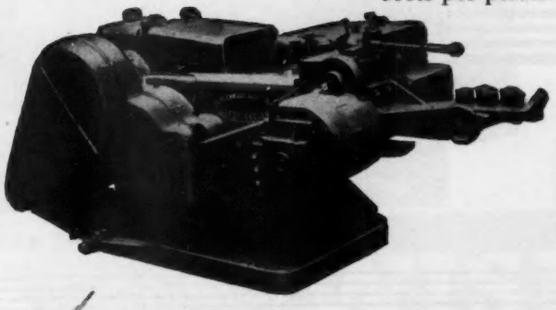

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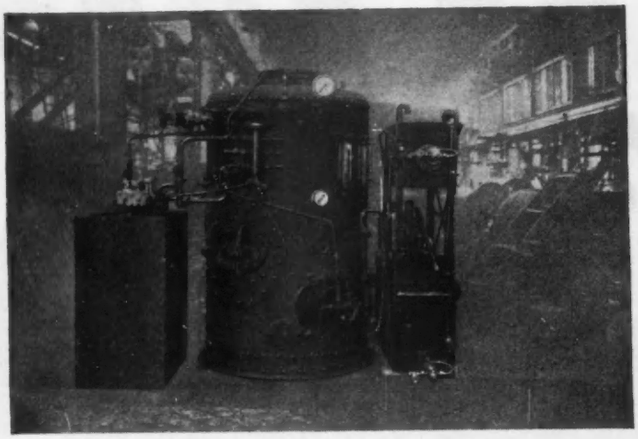

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	cu. in.	c.c.			r.p.m.	ft. in.	mm.	ft. in.	mm.
B	103	1,690	Sp. G. x 2·5	7½	710	5 0	1,524	4 0	1,218
00	263	4,310	Sp. G. x 4	10	485	8 0	2,436	4 0	1,218
1	1,140	18,700	Sp. G. x 24	40	485	13 6	4,114	7 6	2,286
3A	4,562	74,750	Sp. G. x 100	100	485	15 0	4,572	8 0	2,436
9	11,443	187,500	Sp. G. x 225	200	485	33 0	10,100	9 6	2,895
11	15,469	253,500	Sp. G. x 300	250	485	27 0	8,228	11 0	3,352

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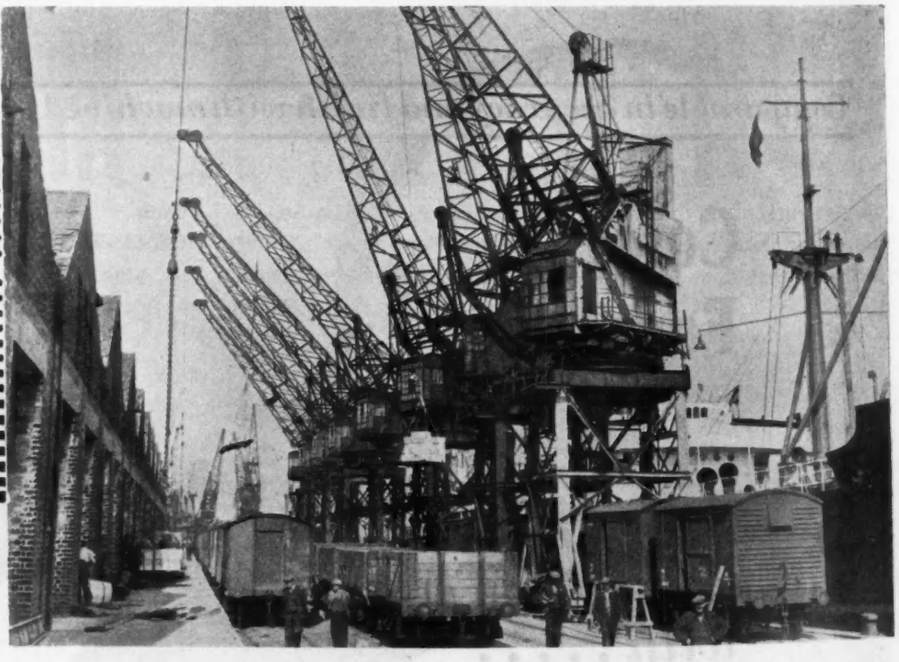

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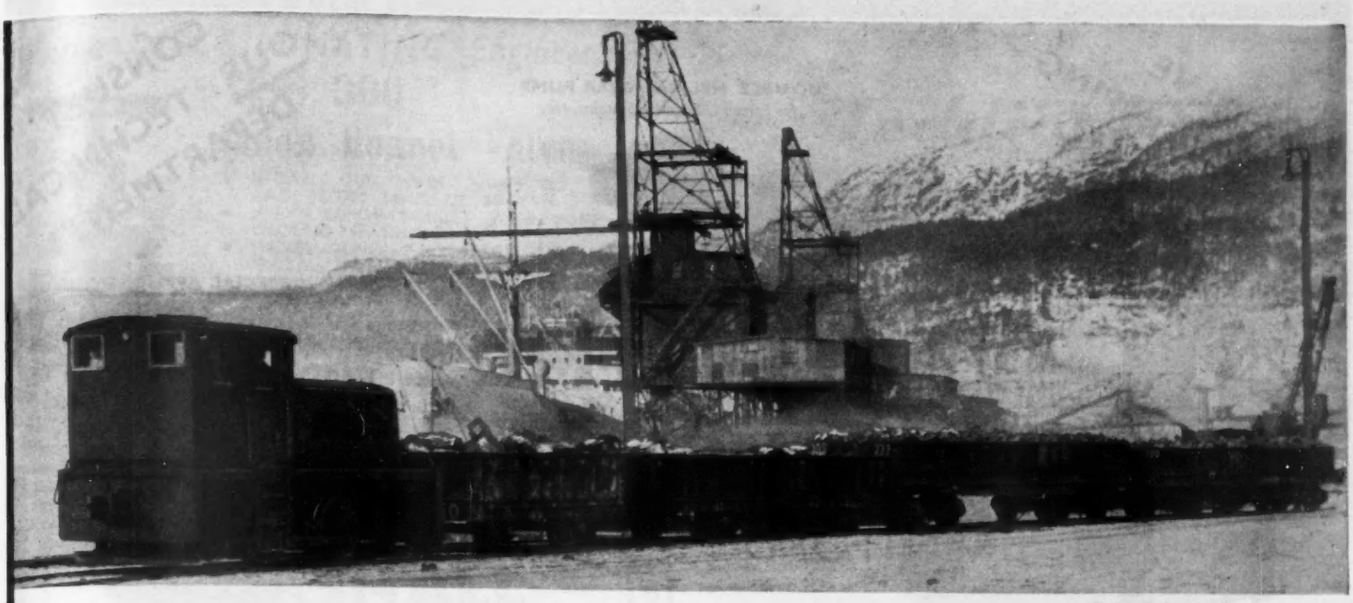

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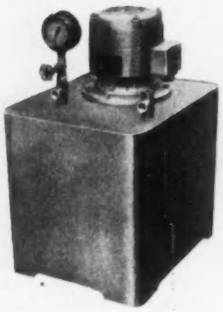

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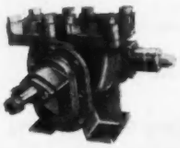

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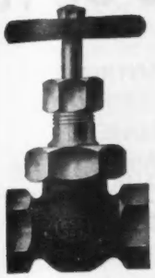

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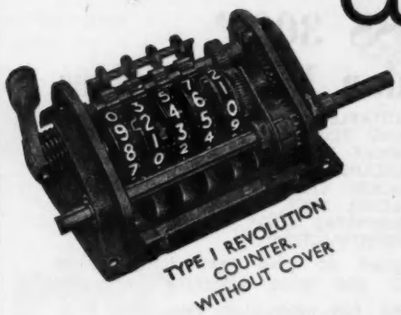

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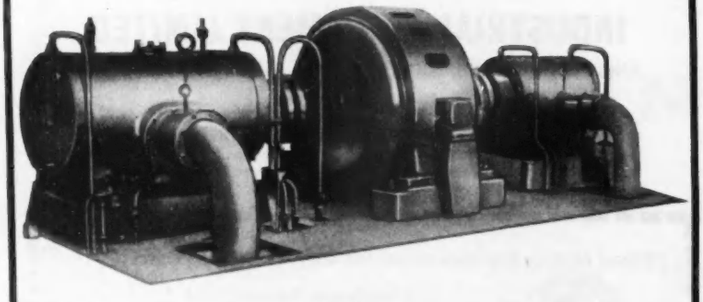

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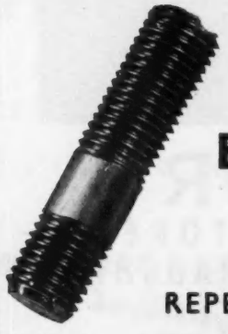

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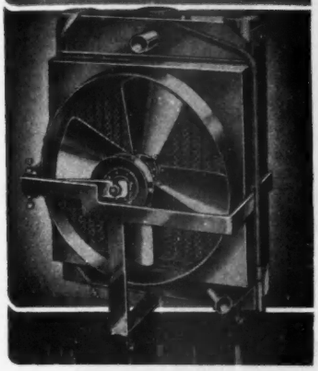

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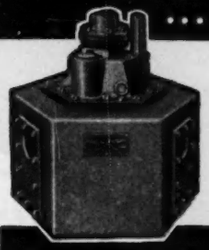

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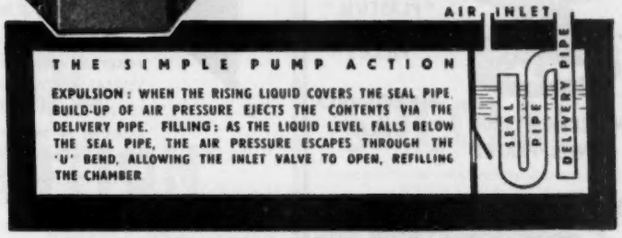

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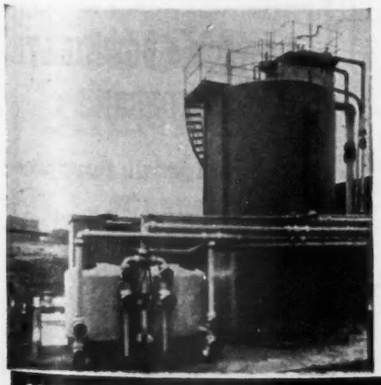

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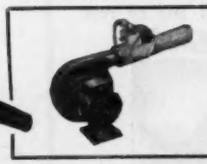

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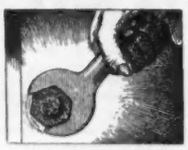

This penetrating oil fluid quickly breaks down rust formation and frees with ease nuts, bolts, screws and all metal held fast by rust. In tins from 4oz to 1 gal.

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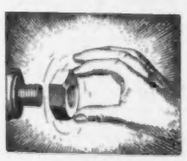

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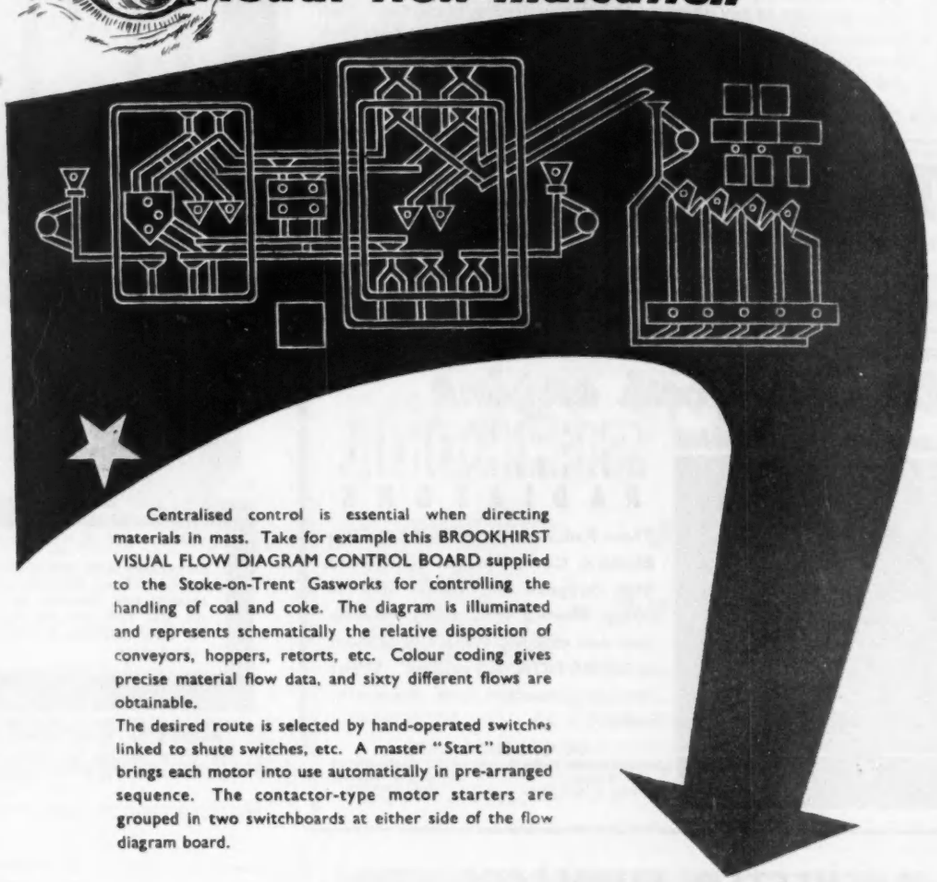
visual flow indication



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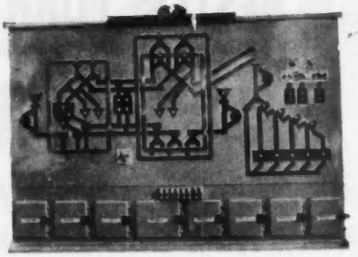

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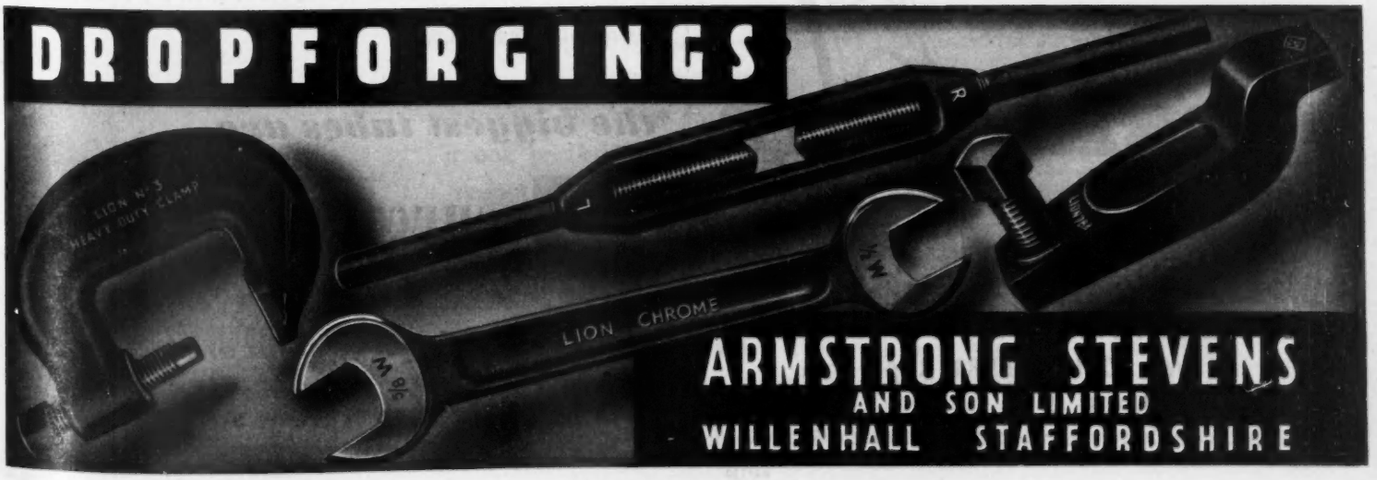

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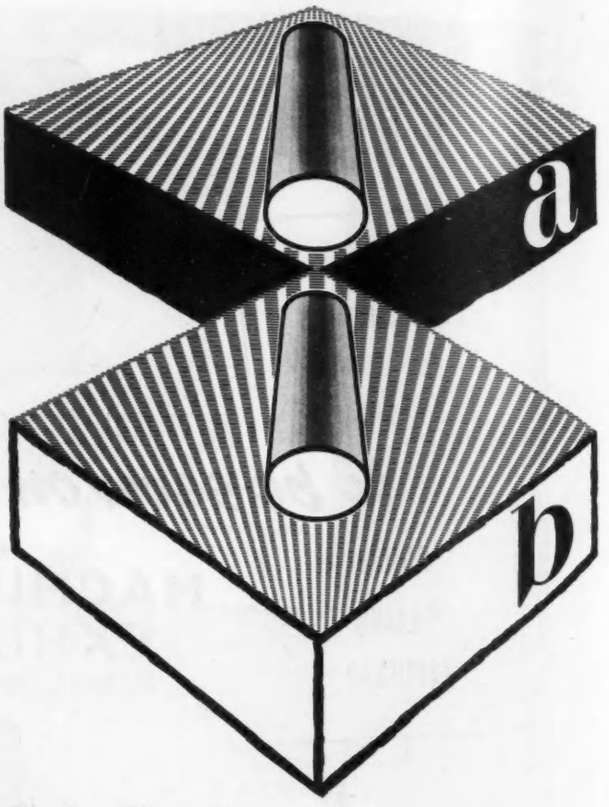

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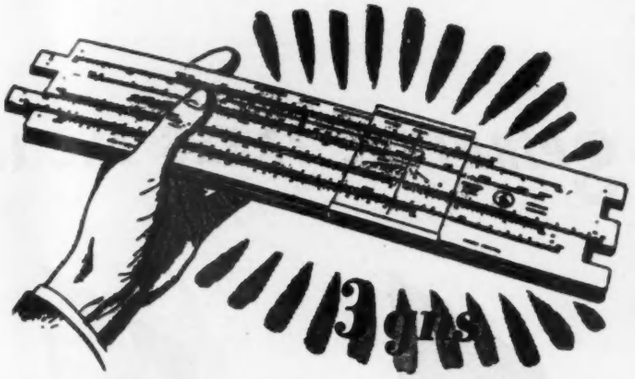

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DISMANTLING AND DEMOLITION DEPARTMENT
RAW MATERIALS DIVISION

GEORGE COHEN
THE 600 GROUP OF COMPANIES
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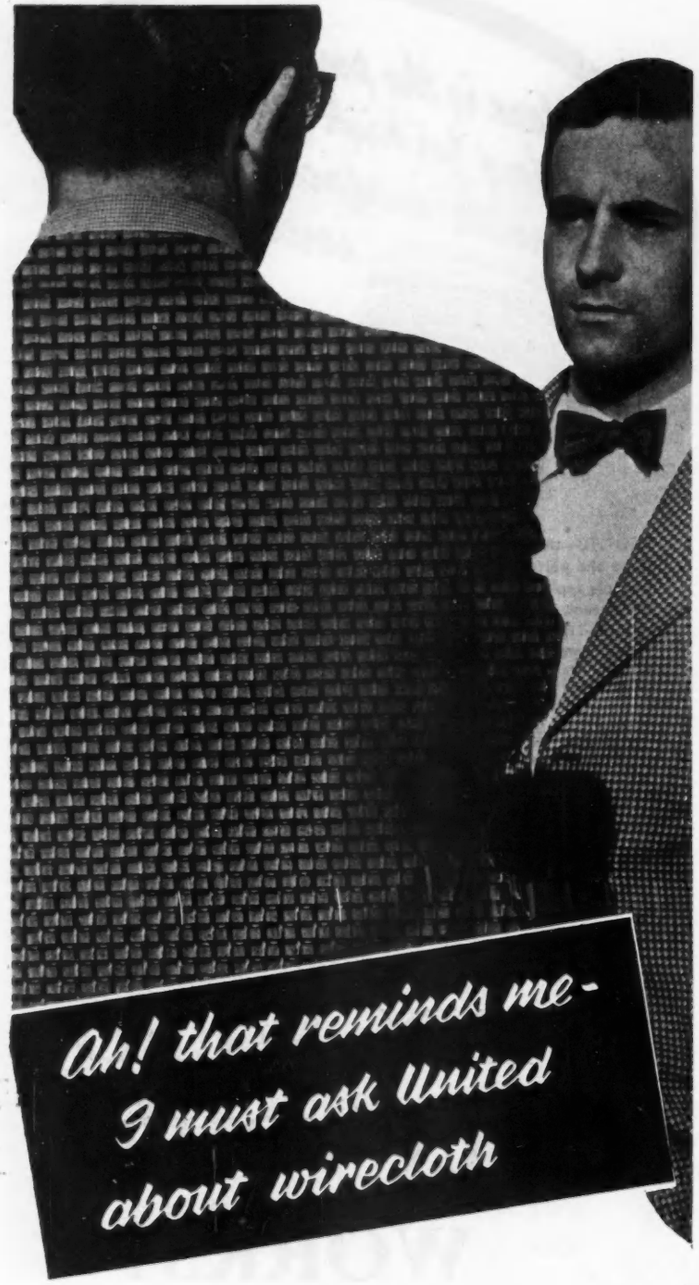

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Gas-laden air from a tanker or the fumes from a laboratory retort . . . complicated tunnel ventilation or a simple hot air system—all jobs for SPIRATUBE, which is proving every day that it is the most versatile flexible ducting now available to industry. For machine shops, garages, factories, mines, aircraft, there are special types of SPIRATUBE in diameters from 3" to 30" and in a variety of coverings. SPIRATUBE is simple and quick to instal and is light, tough, flexible, retractable. Economical too, because SPIRATUBE can be dismantled and used again and again.

Write to-day for the SPIRATUBE Brochure which illustrates what this versatile ducting will do. Put your problems up to our Design Engineers. They will be glad to advise you without cost or obligation. The address is—

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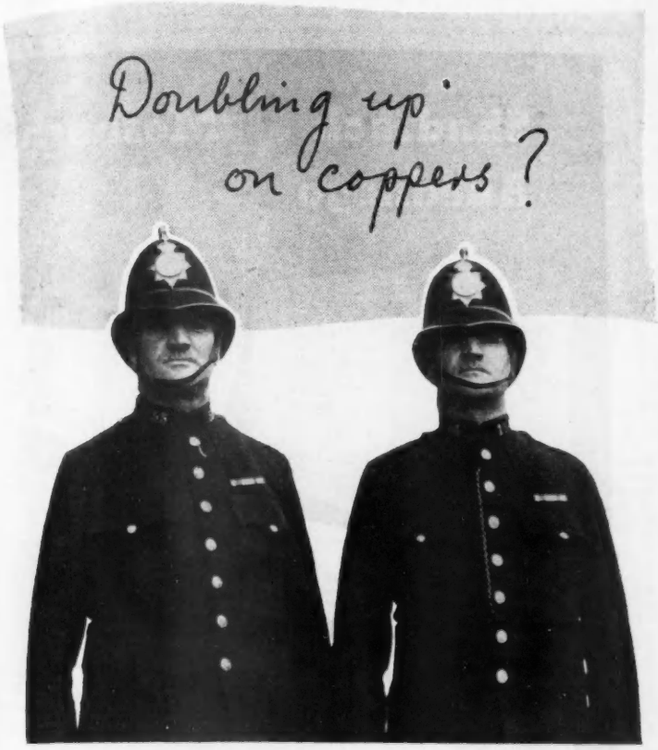

Two coppers aren't always better than one. A correctly trapped one can be more productive than two not properly exploited. Before doubling your coppers, ask us.

Not only coppers, but any other kind of larger steam process plant. The kind that has a high rate of heat transfer compared to the actual heating surface. Where large quantities of condensate must be got rid of, steadily and continuously.

Ask us now, because the well-tried Spirax FT range of ball-float traps has just been reinforced with two brand new and brilliant series.

They are the (1½in.) FT 700, of great discharge capacity, and the (2in.) FT 800, with greater capacity still. Their malleable iron casings are surprisingly moderate in bulk. In all but the highest of the four pressure ranges (up to 20, 60, 120 and 200 p.s.i.) they have thermostatic air vents or steam lock releases interchangeable *mutually or between series*. And easily accessible for changing at that.

The request slip will bring full information about the extended Spirax FT range. Acting "on information received" should then prove beneficial.

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Footnote

To SPIRAX-SARCO LTD.
CHELTENHAM, Glos.
Please send Pamphlet 111 and details of the new FT 700 and FT 800 series

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ADDRESS

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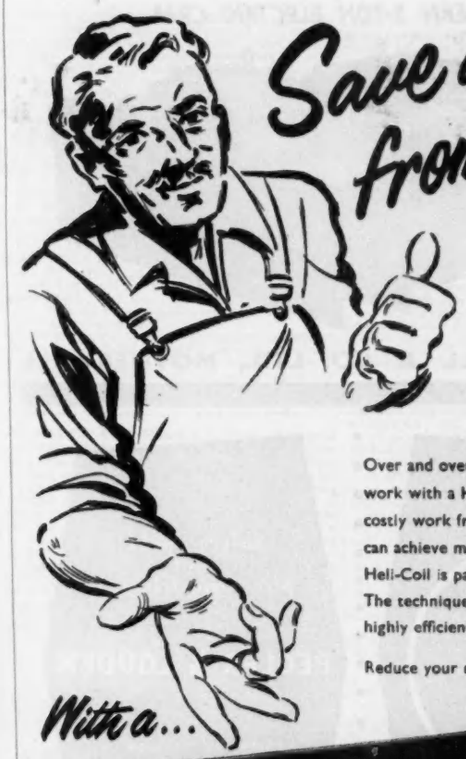

Over and over again a few minutes work with a Heli-Coil Kit will save costly work from scrap. No shop can achieve maximum output unless Heli-Coil is part of its equipment. The technique is rapid, simple and highly efficient.

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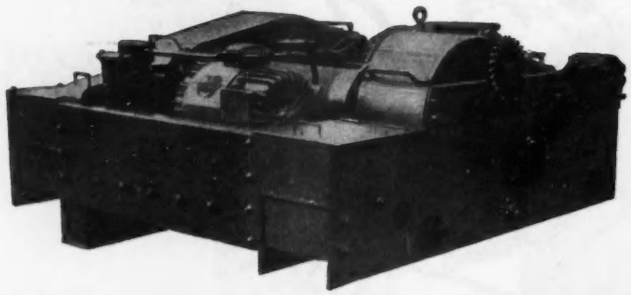

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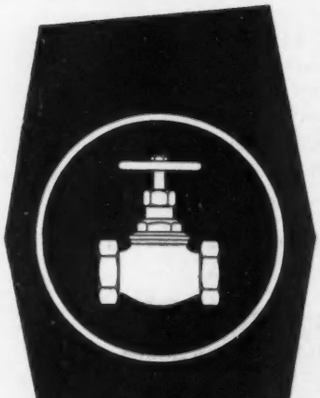

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We're losing our grip SAID THE NUT TO THE BOLT

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Forget about vibration and slackness—fit a Kolok Positive Lock Washer between each nut and bolt.

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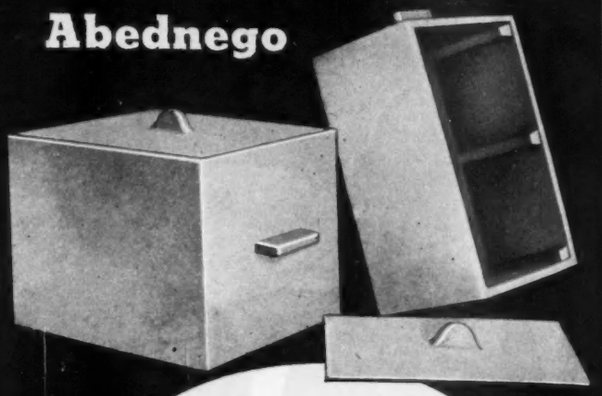

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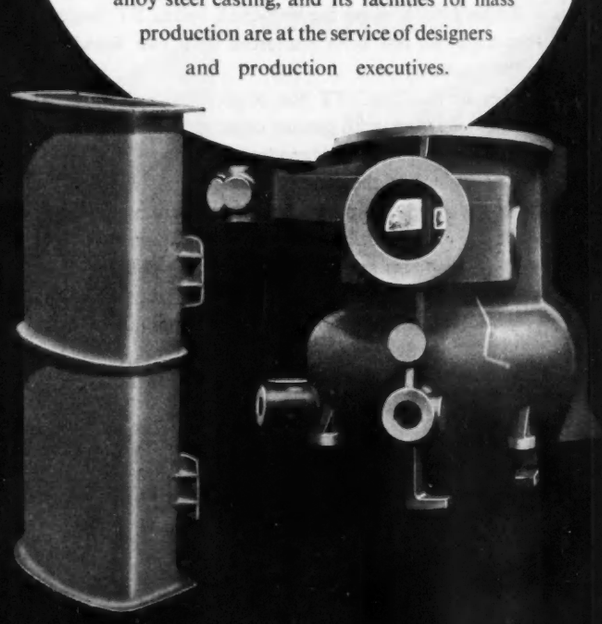

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STEEL FOUNDRIES LTD
THORNABY-ON-TEES
(Subsidiary of Head Wrightson and Co Ltd)

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Classified Advertisements continued from Page 5

SENIOR DRAUGHTSMEN (GENERAL LIGHT ENGINEERING)

with HIGHER NATIONAL CERTIFICATE, or equivalent, required by

ASSOCIATED ELECTRICAL INDUSTRIES RESEARCH LABORATORY

Excellent prospects of promotion to higher grades.

The Laboratory serves a large group of companies. It is situated in pleasant rural surroundings near Reading with a fast train service to London. Please write giving full details of qualifications and experience, quoting reference No. DO/8/2, to Personnel Officer,

Research Laboratory,

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED

Aldermaston Court,

Aldermaston, Berkshire.

M 141

ESTIMATOR required by PETER LIND & CO., LTD., ROMNEY HOUSE, TUFTON STREET, WESTMINSTER, S.W.1. Candidates must have good all-round experience in Civil Engineering work, more particularly the design of temporary works such as stagings, cofferdams, etc.—Apply in writing only, giving age and full description of experience and stating salary required. M 147

ENGINEERING OPPORTUNITIES IN CANADA.

BRITISH INSULATED CALLENDER'S CABLES LTD., are seeking to recruit in this country a number of

ENGINEERS to fill vacancies with Phillips Electrical Company, Limited, their Canadian Associate in Ontario engaged in the electric cable industry. The vacancies concerned, which offer excellent pay rates and opportunities for advancement, are in the Design, Maintenance, Production and Sales field. For the Maintenance post it is hoped to engage a person in the 30/35 age range with a sound practical background and several years' experience of factory maintenance. For the remaining positions younger mechanical or electrical engineers are required, preferably with 2/3 years industrial experience but this is not essential and applications from recently qualified men can be considered. In all cases technical qualifications should be to degree standard or equivalent.—Further information can be obtained and interviews arranged through the STAFF OFFICER, B.I.C.C., LTD., PRESCOT, LANCS. M 146

ENGINEER FOR TECHNICAL ENGINEERING DEPARTMENT.

Duties include the preparation of schemes for new thermal and nuclear energy power plants, both industrial and central and also the technical analysis of existing plants. Candidates will be expected to provide evidence that their technical and practical background is such as will enable them to assess correctly a client's plant requirements and also to determine the suitability of plant offered by a manufacturer. The work involves a knowledge of thermodynamics, fluid flow mechanics, physics and the application of these to power plant problems; for these reasons the possession of a good technical qualification in engineering is desirable. The successful candidate will be centred in London, but will be expected to undertake short visits to plant sites as required. Applications, giving details of training, qualifications and experience to date, for the above positions, should be sent to the PERSONNEL OFFICER, EWBANK & PARTNERS, LTD., ENGINEERING CONSULTANTS, 10/11, GROSVENOR PLACE, LONDON, S.W.1. M 144

BRITISH PETROLEUM COMPANY LIMITED has vacancies for

MECHANICAL ENGINEERS at their ADEN Refinery. Applicants, aged 25-35, must possess either National Certificate or Diploma preferably at Higher Level or A.M.I.Mech.E. or 1st or 2nd Class M.O.T. Certificate or B.Sc. Degree. Full engineering apprenticeship essential, except in the case of those holding B.Sc. Degree, followed by three years suitable experience in industry. Attractive salary plus generous allowance in local currency, free passages out and home, free medical attention, good leave arrangements, Pension Scheme, kit allowance and air-conditioned accommodation.—Write, giving full details of qualifications and experience, quoting P.506B, to BOX 1811, c/o 191, GRESHAM HOUSE, E.C.2. G 669

SENIOR DRAUGHTSMAN required by manufacturing confectioners for interesting work, including plant layout and special purpose machine design. Applicants should be aged between 25/40 and a knowledge of the food industry would be an advantage. Applications, giving full personal particulars and details of positions held and present salary to be addressed to PERSONNEL MANAGER, JAMES PASCALL LIMITED, STREATHAM ROAD, MITCHAM, SURREY. M 113

BRITISH PETROLEUM COMPANY LIMITED offers

STUDENT APPRENTICESHIPS in Instrument Engineering, Chemical Engineering and Chemistry which provide training for young men and lead to full professional qualifications. Age 18-19. Minimum qualifications required for Instrument Engineering—a good G.C.E. with "A" level Mathematics and Physics. For Chemical Engineering and Chemistry Apprenticeships—"A" level Mathematics, Physics and Chemistry are required. Apprentices will attend a Technical College for full-time study for six months of every year. The other six months are spent in a Refinery undergoing practical training. The duration of the apprenticeship is four years.—Written applications giving details of education and experience should be addressed to BOX 9030, c/o 191, GRESHAM HOUSE, E.C.2. M 176

METALLURGIST required for Iron Foundry—South East England. Experience of melting, sand control and mechanised production preferred. Pension Fund and Employees' Share-holding Scheme operated.—Write, stating age, experience and salary required, to BOX M 149, Offices of ENGINEERING.

JUNIOR DRAUGHTSMEN required, O.N.C. standard, experience in general engineering and/or sheet metal fabrications for work on specialized equipment for the Dairy, Brewery and Chemical Industries.

Salary commensurate with experience.—BOX M 179, Offices of ENGINEERING.

JOHNSON, MATTHEY & CO., LIMITED, precious metal refiners and high precision engineers, invite applications for the following appointments:

SENIOR MAINTENANCE ENGINEER.

For works in North London. Applicants should be 30-45 years with good basic workshop training, a practical outlook and previous experience of steam, gas and air services, of the installation and maintenance of plant and of handling labour. Some experience of chemical plant maintenance would be desirable though not essential.

The Company also has vacancies for:

ENGINEERING DRAUGHTSMEN.

With plant design and maintenance experience, and ability to lay out plant and services. Works in the initial stages will be concerned with the equipping of a new factory housing chemical process plant (not mass-production), and thereafter on development.

TOOL DRAUGHTSMEN

A high standard of quality is necessary for the work which will be concerned with the design of press tools, and some previous experience with this is preferable. Applicants should be of at least O.N.C. standard.

Appointments will be to the Company's established staff, and conditions of service include an annual bonus, free lunches and superannuation scheme.—Write, giving full details of age, qualifications and experience, to THE SECRETARY, 78, HATTON GARDEN, LONDON, E.C.1. M 110

A PROJECT ENGINEER is required for original and interesting work in connection with A/C systems for use in automobiles. He would be expected both to draw up plans for the complete electrical installation and to justify its use. This work therefore requires an engineer with the ability not only to design devices for ignition, voltage control and the like, but also to make critical appreciations of the schemes he proposes. Applicants should be graduate electrical engineers and should preferably have served an engineering apprenticeship. Previous experience of transistors or electronic circuits would be useful although not essential.—Apply in writing stating age, qualifications and experience to the PERSONNEL MANAGER, JOSEPH LUCAS (ELECTRICAL), LTD., GREAT KING STREET, BIRMINGHAM 19, quoting reference PM/D/134. M 185

WANTED.

QUALIFIED MECHANICAL ENGINEER for British Managed Vegetable Oil Processing Factory in Bombay. General mechanical and electrical experience in Vegetable Oil or Food Factory desirable.—Apply BOX M 105, Offices of ENGINEERING.

P.E. MANAGEMENT GROUP LTD. requires **MEN TO FILL INTERESTING APPOINTMENTS** in the following companies:—

PRODUCTION ENGINEERING LTD.
MARKETING DEVELOPMENT CO. LTD.
COMBINED TECHNICAL SERVICES LTD.
and companies overseas.

Applicants to be 27-40 years of age with a University degree or equivalent qualifications and having had experience in industry. Qualified engineers are particularly required. For men with the right qualifications and experience there is ample scope for advancement within the Group of companies on work which is wholly of a management or technical consulting nature. Service abroad for long or short periods only if desired.

A four-figure starting salary, non-contributory superannuation life assurance and a profit-sharing scheme are part of the remuneration arrangements.

Apply to P.E. MANAGEMENT GROUP LTD., 12, GROSVENOR PLACE, LONDON, S.W.1. M 139

DRAUGHTSMEN.

EDWIN DANKS & CO. (OLDBURY) LTD., OLDBURY, NR. BIRMINGHAM—manufacturers of all types of Pressure Vessels have vacancies for **SENIOR DRAUGHTSMEN AND DETAILING DRAUGHTSMEN.** The work, which is interesting covers a wide field in the design of all classes of welded vessels for Industrial Plants, Chemical Plants and Oil Refining Plants.

The positions are permanent, and the Company has a contributory pension scheme and other facilities and conditions associated with first-class employers.

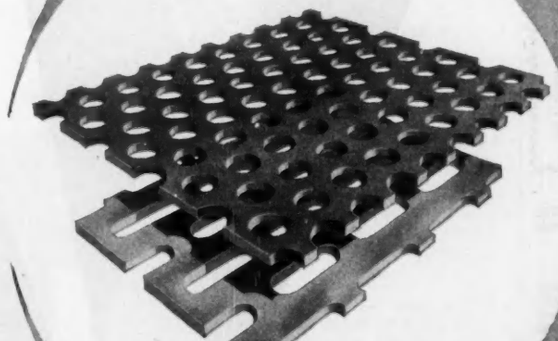
Applicants should be competent men, able to work with a minimum amount of supervision.

Please write, giving age, details of training and experience.

Salary according to qualifications and experience, interesting work and canteen facilities provided.

Apply:—CHIEF ENGINEER, EDWIN DANKS & CO. (OLDBURY) LTD., OLDBURY, NR. BIRMINGHAM. M 180

Perforated METALS....



ANY SIZE OR SHAPE OF HOLE.....
IN ALL METALS.....
ACCURATE & DURABLE

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THE HEAD WRIGHTSON MACHINE COMPANY LIMITED,

invite applications from first-class

DESIGN ENGINEERS AND SENIOR DRAUGHTSMEN

who would be interested in progressive positions in a special development department which will shortly be opened to deal with a wide range of problems affecting several industries.

The Company has a good Pension Scheme and allows generous holidays. Men having a sound technical training and a flair for design are recommended to submit applications marked "Private (Development)," to :—MANAGING DIRECTOR, HEAD WRIGHTSON MACHINE COMPANY LTD., COMMERCIAL STREET, MIDDLESBROUGH. M 157

BRITISH PETROLEUM COMPANY requires an **EXPEDITING ENGINEER** for employment in the Newcastle-Durham area. Applicants, aged 30-40, must have served a full five year apprenticeship followed by workshop and manufacturing experience with preferably some years spent on inspection. Knowledge of Petroleum equipment suppliers situated in N.E. England is desirable. Salary according to age, qualifications and experience. Non-contributory Pension Scheme.—Write, giving full details, quoting H.3813, to BOX 9022, c/o 191, GRESHAM HOUSE, E.C.2. M 130

DESIGN ENGINEER.

COURTAULDS LIMITED requires a **DESIGN ENGINEER** at its Engineering Headquarters in Coventry for development work on man-made fibre-making plant and machinery. A good engineering degree is essential, and several year's industrial experience in the design and development of chemical, textile, or allied process plant and machinery is desirable. Age 27 to 40. Applicants should have an aptitude for solving design problems and calculations in this type of engineering.

Candidates should write giving full personal particulars and details of experience to the DIRECTOR OF PERSONNEL, COURTAULDS LIMITED, 16, ST. MARTINS-LE-GRAND, LONDON, E.C.1, quoting reference number B.36. L 925

ENGLISH ELECTRIC

JUNIOR ENGINEERS required for very interesting development work connected with a number of mechanical engineering subjects.

These men will be required to assist in devising and carrying out experiments on problems connected with **LUBRICATION, VIBRATION, HEAT TRANSFER, THERMODYNAMICS, FLUID DYNAMICS, STRUCTURES, MECHANISMS, ETC.**

The essential requirements are a practical engineering training and an education up to Higher National Certificate standard, together with some previous development or Drawing Office experience. A real interest in research or development is necessary. These vacancies are at Whetstone near Leicester in a modern laboratory offering good conditions of employment.

Please apply to DEPT. C.P.S., 336/7, STRAND, LONDON, W.C.2, quoting ref. 1817D. M 192

DRAUGHTSMEN (SENIOR AND JUNIOR) required for work in connection with the following branches of Coke Oven and Gasworks plants.

(a) Mechanical and By-Product Plant.
(b) Pipework.
(c) Steelwork for Buildings and Conveyors.

Applicants should be competent men able to work with the minimum of supervision. Technical qualifications to O.N.C. or beyond. Good remuneration and prospects for capable men. Pension scheme. Five-day week; Canteen Facilities.—State age and experience to the PERSONNEL OFFICER (D.O.), WOODALL-DUCKHAM CONSTRUCTION COMPANY LTD., WOODALL-DUCKHAM HOUSE, 63-77, BROMPTON ROAD, LONDON, S.W.3. G 550

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BRITISH TWIN DISC AND CLARIFIERS LTD.
AMBERLEY HOUSE, NORFOLK STREET, LONDON, W.C.2.

TECHNICAL ENGINEER required by WRIGHTS' ROPES LIMITED, BIRMINGHAM, 9, to study design and application of Steel Ropes. Sound practical knowledge mechanical handling and/or mining engineering essential. Previous experience of Steel Ropes not necessary provided adaptable. Pension Scheme.—Write ADMINISTRATIVE OFFICER with full details. M 127

ASSISTANT METALLURGIST required for Commercial Motor Vehicle Manufacturers. Candidates must be experienced in metallography and production heat treatment of steels. Applications, in writing, giving details of qualifications, experience and salary required, to A.E.C. LIMITED, STAFF RECORDS OFFICE, WINDMILL LANE, SOUTHALL, MIDDX. L 926

JUNIOR DRAUGHTSMEN, having completed National Service, required for work on large chemical plant installations, A.E.S.D. minimum rates or above. Five-day week and superannuation scheme.—Apply by letter giving details of technical education to the CHIEF DRAUGHTSMAN, LAPORTE CHEMICALS LIMITED, CLIFTON HOUSE, EUSTON ROAD, LONDON, N.W.1. G 665

Heavy Engineers in the Trafford Park Area require **A WELDING SUPERVISOR** who must be experienced in gas and electric welding. Also familiar with argon and submerged arc processes. Experience of flash and spot welding desirable. Some metallurgical knowledge essential. This is a superannuable position with excellent prospects. Applicants must give full particulars and mark applications for the attention of the PERSONNEL MANAGER.—BOX L 976, Offices of ENGINEERING.

ENGINEERS AND ASSISTANT ENGINEERS preferably qualified and having had site experience, required for design work in London Office of Substantial firm of Civil Engineering Contractors near Victoria. Salary commensurate with ability, benefit of Superannuation Scheme.—Apply with full details to BOX L 960, Offices of ENGINEERING.

HEAD WRIGHTSON & CO., LTD.,

(McKee Iron and Steel Division) have several vacancies for

STRUCTURAL AND MECHANICAL DESIGNER DRAUGHTSMEN

(SENIOR AND JUNIOR) for work on the design of Materials Handling, Blast Furnace and Gas Cleaning Plants.

Applicants should preferably have experience of Iron and Steel Works Practice, but applications will be considered from draughtsmen wishing to take up this class of work.

Excellent working conditions; five-day week; pension scheme.—Applications, stating age, qualifications and salary required, to:—PERSONNEL MANAGER, REF. M.K./12, TEESDALE IRON WORKS, THORNABY-ON-TEES. M 158

....the world's best HACK SAW BLADE

Made by James Neill & Co. (Sheffield) Ltd., and obtainable from all tool distributors

SHEFFBRIDGE ENGINEERING LIMITED, CHESTERFIELD, offer attractive opportunities for **SENIOR DESIGNERS** capable of upgrading to project work; experienced in Material Handling Plant for Quarries and Collieries. Applications from Designers and Draughtsmen with qualifications in General Engineering will also be given consideration for duties of a suitable nature. Progressive superannuated positions, attractive salaries commensurate with qualifications and experience, with provision of houses for senior positions if required.—Apply, giving details of qualifications, experience, etc., and quoting reference EQD, to the PERSONNEL MANAGER. L 935

There is an opportunity for a **DEVELOPMENT ENGINEER AND DRAUGHTSMAN** who seeks an interesting and varied career to join the staff of a leading industrial organisation. Experience is required in design of special purpose machine tools, layout of services, handling of plant engaged on large and small pressed steel components.

Ability to follow a job through to completion is required. Education to H.N.C. or equivalent is preferred.

Pension and Sickness insurance Schemes and Canteen facilities are available.

Application should include details of age, experience and salary required to:—CHIEF ENGINEER, JOHN THOMPSON MOTOR PRESSINGS, LIMITED, WOLVERHAMPTON. M 40

CHIEF ENGINEER. Leading British Company with overseas connections requires a Chief Engineer to supervise the civil, mechanical and electrical constructional work on site of a major engineering project. Applications will be considered only from senior engineers with wide experience of such work. The post is a home appointment and depending upon experience, carries a salary in the range £2500 to £3500. Amenities include a house purchase scheme and pension fund. Applications will be treated as strictly private and confidential and should state age, qualifications, experience and present salary to OX M 81, Offices of ENGINEERING.

Applications are invited from

GRADUATES *to fill three vacancies on the* SENIOR STAFF of our PRODUCTION DEVELOPMENT LABORATORIES.

In all cases the work is associated with the development of light electrical equipment for large quantity production, but the nature of the problems to be dealt with are such that the positions call for a mechanical engineer, an electrical engineer and a physicist or electrical engineer respectively. A commencing salary of up to £1000 p.a., or more in special cases, will be paid and the positions offer excellent prospects of rapid advancement.

Apply in writing, stating age, qualifications and experience, to the

Personnel Manager, Joseph Lucas (Electrical) Ltd., Great King Street, Birmingham 19, quoting ref. PM/D/133.

M 131

SERVICES ENGINEER.

B.X. PLASTICS, LTD., BRANTHAM WORKS, NR. MANNINGTREE, ESSEX, require a Services Engineer with wide experience for the Brantham factory. Applications are invited from men with good experience in power generation, steam and electrical distribution, building work, and hydraulics. Age: between 30 and 35. Salary by arrangement. Applications which will be treated in confidence should give previous experience and qualifications, and be addressed to the PERSONNEL MANAGER AT BRANTHAM WORKS. M 44

THOMAS GLOVER & COMPANY invite applications for the position of **ASSISTANT WORKS MANAGER** at their Edmonton factory. Applicants should possess proved administrative ability and have had considerable experience of production methods in the Light Engineering Industry. Age 30 to 45 years. Commencing salary will be not less than £1250 per annum with good prospects. A superannuation scheme is in force.—Applications stating age, qualifications, experience and present salary should be addressed to the MANAGING DIRECTOR, T. GLOVER & CO., 48, GROSVENOR GARDENS, LONDON, S.W.1. M 189

A. REYROLLE & CO., LTD., OF HEBBURN-CO. DURHAM, who are the largest firm of switch, gear specialists in the world, have vacancies for **CONTRACTS ENGINEERS,** both for home and overseas contracts work on E.H.V. and H.V. switchgear. The appointment would be for work at Hebburn, and it is customary for the Company to appoint engineers for duties in the overseas and home area offices from engineers trained at Hebburn. The work requires initiative and affords the engineer individual responsibility. It is interesting and varied and calls for ability to conduct both technical and commercial negotiations. The desirable qualifications are therefore a Degree or a Higher National Diploma or Higher National Certificate, but candidates having an Ordinary National Certificate who are still proceeding with studies could be considered specially. Applicants need not have specialised previously in switchgear, and, if necessary, suitable introductory training would be arranged. Applications, giving full particulars of technical training and previous experience, should be forwarded to the CONTRACTS MANAGER, A. REYROLLE AND CO., LTD., HEBBURN, CO. DURHAM, marked "PERSONAL." L 892

DESIGN ENGINEERS required by progressive company manufacturing fuel injection and electrical equipment. London area. Monthly staff appointments with appropriate pension and holiday privileges. H.N.C. desirable but not essential. Write full details including age, education, experience, employment history including present employment and salary in strict confidence quoting Ref. E.D. 2 on letter of application to BOX M 76, Offices of ENGINEERING.

STRUCTURAL ENGINEER

required

with experience in prestressed concrete, to take charge of small drawing office and assist in development work.

Salary £1000 to £1250 according to experience.

Applicants should send details of qualifications and experience to :—

UDALLS, WEST QUAY ROAD, SOUTHAMPTON. L 936

BRUSH ELECTRICAL ENGINEERING COMPANY, LTD., LOUGHBOROUGH, LEICS.

Owing to expansion in the Turbine Division vacancies occur for the following personnel:

DESIGN ENGINEER with experience of mechanical design for interesting design work on radial flow steam turbines.

DESIGN ENGINEER for design work on axial flow turbines. Previous experience of mechanical design and/or operational experience with this type of turbine would be an advantage.

DEVELOPMENT ENGINEERS (two vacancies). Applicants should preferably have had experience of development work and should be capable of handling design, operation and performance analysis. A knowledge of electronic equipment for vibration stress analysis would be an added advantage.

Candidates for all posts must hold an engineering degree, H.N.C. or other equivalent qualifications and should have served an engineering apprenticeship. A good salary will be paid and conditions of service include staff bonus, non-contributory superannuation scheme. There are excellent opportunities for young engineers seeking a progressive appointment with a vigorous and expanding Company. Please reply to the CHIEF PERSONNEL OFFICER. M 77

OIL AND CHEMICAL PLANT CONSTRUCTION PROJECT

MANAGERS AND SUPERVISORS

REQUIRED FOR WORK IN MIDDLE EAST, FAR EAST AND UNITED KINGDOM.

Vacancies exist for

MANAGERS and **SUPERVISORY ENGINEERS** capable of taking charge of field project organisations varying from a single plant or unit to projects comprising complete refineries with field forces consisting of upwards of 150 staff and 3,000 men. Applicants must have held responsible positions in similar capacity and must have some years of experience in field construction of oil or chemical plants. Chief qualifications required are good organising and administrative ability, with sound knowledge of the following branches of engineering activity:—Drafting, Civil, Mechanical, Electrical, Welding, Vessels and Piping, Field Office organisation covering staff, labour, costs and materials. Top age-limit for work outside U.K. is 55 years. Applicants must be physically fit and prepared to reside at site of work with or without family for periods varying from 6 months to 2 to 3 years, according to the magnitude and location of the project. Salary and allowances will be substantial and commensurate with experience and ability of applicants.

Top men only need apply. Applications, giving details of past experience and positions held, should be marked "Confidential" and will be treated accordingly.

CONSTRUCTION MANAGER (PROCESS PLANTS), FOSTER WHEELER, LIMITED, 2, IXWORTH PLACE, LONDON, S.W.3. M 5

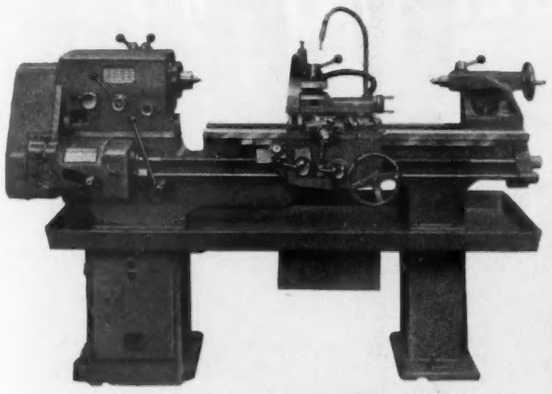
Classified Advertisements continued on Page 116

on stand no. 74

at the

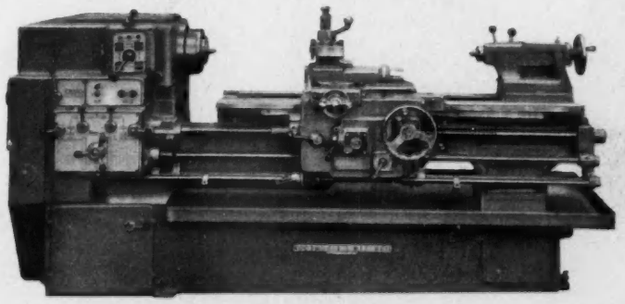
MACHINE TOOL EXHIBITION OLYMPIA

22nd JUNE—6th JULY



The 70 Junior SS and Sc. Lathes 7in. centre. Admits 3ft. between centres. 8 spindle speeds. Can be supplied in various bed lengths up to 9ft.

Series 85, SS and Sc. heavy duty Lathes 8½in. centres, length of bed 8ft., 12 spindle speeds. Can also be supplied with 10ft. or 12ft. bed length.



Other exhibits include :—
"Series 85" 10½in. Centre lathe. Turret Milling Machine 36in. by 9in. table, and also a model to ¼ scale of a new Horizontal Boring, Facing and Milling Machine at present in course of production.

WOODHOUSE & MITCHELL

WAKEFIELD RD. BRIGHOUSE

PHONE : BRIGHOUSE 627 (3 LINES) GRAMS : 'WOODHOUSE, BRIGHOUSE'.

W.MMT.2.

ASSISTANT ENGINEERS required with experience in design and layout of liquid fuel burning systems applied to new and existing boiler plants and industrial furnaces. Applicants without specialised knowledge in oil burning would be considered for training if they have reached O.N.C. Five-day week and superannuation.—Applications, giving particulars of education, qualifications and previous experience, will be treated in confidence and should be addressed to R. L. COX, G. N. MADEN AND SONS, LTD., 19, WOBURN PLACE, W.C.1. M 107

A large diesel engine manufacturing company invites applications for the appointment of **CHIEF DRAUGHTSMAN** to supervise a production and contractual drawing office of about 40 draughtsmen. Candidates should be Corporate Members of the Institution of Mechanical Engineers, and should have had experience in a similar capacity although it is not essential that they should have specialised knowledge of heavy engines. Applicants in the age group 35-45 will have preference.—Applications in confidence to BOX M 106, Offices of ENGINEERING.

RESIDENT ENGINEER capable of combining the duties of Clerk of Works required for piling and R.C. building contract, value approximately £250,000 at Barking, Essex. At least 3 years' experience as R.E. or on R.E.'s staff, but contractor's engineer with good experience would also be considered. Some professional qualifications desirable. —Apply, stating age, experience, salary required and earliest date when free, to : FARMER AND DARK, ROMNEY HOUSE, TUFTON STREET, S.W. M 178

CLEVELAND BRIDGE & ENGINEERING CO., LTD., have vacancies for **QUALIFIED CIVIL ENGINEERS,** Structural Engineers and Designer Draughtsmen, mainly on bridgework in the U.K. Salaries commensurate with experience. Pension scheme available. Posts in Darlington, Doncaster, Preston.—Apply in writing to THE MANAGING DIRECTOR, POST BOX NO. 27, DARLINGTON, CO. DURHAM. M 177

TECHNICAL DIRECTOR—Leading British Company with headquarters in London wishes to appoint a Technical Director. The position requires an experienced engineer, highly qualified, with wide experience in the design and construction of major engineering projects involving mechanical, civil and electrical engineering. The candidate appointed will have a seat on the Board and will be responsible for the general administration and co-ordination of the design and engineering organisation involving the control of contracts running into several millions of pounds. Applications, which will be treated as strictly confidential, will only be considered from engineers having university degrees and wide experience in the general design of the type of projects referred to in this advertisement. The salary level will be between £3000-£4000. The Company operates a Pension Scheme and facilities for house purchase and removal expenses are available.—Applications should state age, experience, qualifications and present salary, to BOX M 174, Offices of ENGINEERING.

THE SUPERHEATER CO., LTD., 53, HAYMARKET, LONDON, S.W.1, has vacancies for **TECHNICAL DESIGN ENGINEERS.** Knowledge of Thermodynamics, including Combustion and Heat Transfer desirable.

Good working conditions, 5-day week. Pension Scheme.—Write giving full details of qualifications, experience and salary required. M 163

THE SUPERHEATER CO., LTD., 53, HAYMARKET, LONDON, S.W.1, has vacancies for **DRAUGHTSMEN.** Experience of Water Tube Boilers preferred.

Good working conditions. 5-day week. Pension Scheme.—Write giving full details of qualifications, experience and salary required. M 164

RESIDENT ENGINEER to supervise erection contracts for chemical and gasworks plant. Applicants must be experienced in general erection work (other than structures) and in the use of heavy lifting equipment and have a knowledge of welded, riveted and mechanical work.

Apply, stating age, details of past experience and position held, BOX M 162, Offices of ENGINEERING.

BRITISH PETROLEUM COMPANY has a Vacancy for an **ENGINEERING ESTIMATOR** for work in London, with occasional visits abroad. Age 30-35. Mechanical or Civil Engineering degree or equivalent. Applicants should also have served an engineering apprenticeship and had experience in estimating major projects for large engineering organisation. Salary according to age, qualifications and experience.—Applicants should write, stating age, qualifications, etc., quoting H.3620, to BOX 9034, c/o 191, GRESHAM HOUSE, E.C.2. M 206

DEVELOPMENT ENGINEERS of British nationality aged 22-25 are required for work on new and rapidly expanding I.C. engine projects with a West London firm. Applicants should have a degree, H.N.C. or an equivalent qualification, in mechanical engineering. Previous experience on I.C. engines would be an asset but not essential. Salary based on experience and qualifications, but not less than £600 p.a. Pension scheme.—BOX M 199, Offices of ENGINEERING.

DEVELOPMENT ENGINEERS AND PHYSICISTS

are required for work in the new and rapidly expanding laboratories of Louis Newmark Ltd., at New Addington, Surrey. The work includes the design and development of instruments and equipment for the aircraft and allied industries, and some working experience of small electromagnetic instruments is desirable. Good salary based on age and experience. Pension Scheme.—Apply in writing giving full particulars to : PERSONNEL OFFICER, LOUIS NEWMARK, LTD., PREFECT WORKS, PURLEY WAY, CROYDON. M 156

Leading manufacturers of container closures in the Midlands have a number of vacancies for ambitious DESIGN DRAUGHTSMEN preferably with some experience in this or a similar sphere. Interesting work with excellent salary and every opportunity for promotion to senior position in a rapidly growing organisation. Write in confidence with details of experience, positions held, salary required, to P.A. METAL CLOSURES LIMITED, BROMFORD LANE, WEST BROMWICH. G 627

FRASER & CHALMERS ENGINEERING WORKS ERITH, KENT,

have vacancies for a number of

SENIOR DRAUGHTSMEN

with good experience in

Structural or Heavy Mechanical work.

Attractive salaries will be offered to suitable applicants and the positions available offer excellent prospects for advancement.

Present holiday arrangements will be honoured.

Apply to Personnel Manager, giving age and full details of training and experience. M 152

RESEARCH AND DEVELOPMENT ENGINEER aged about 35, to take charge of development department, designing plant, automatic controls and instrumentation for equipment connected with liquid processes. Salary £2000-£2500 depending on experience. West London area. Pension Scheme in operation. Excellent prospects for man with ideas and initiative.—BOX M 190, Offices of ENGINEERING.

QUALIFIED CIVIL AND MECHANICAL ENGINEERS wanted by Consulting Engineers for Middle East. Should have oil experience, preferably of pipelines and pumping stations. Age: 25-45. Liberal pay and free quarters.—Apply by letter with full particulars of age, qualifications and experience, to BOX NO. 102, c/o CHARLES BARKER & SONS, LTD., 31, BUDGE ROW, LONDON, E.C.4. M 160

Applications are invited from

SENIOR DESIGN AND DEVELOPMENT ENGINEERS

with an engineering Degree or equivalent and experience on general mechanical design, for appointments with a leading general Engineering Company.

- *The appointments offer excellent prospects and a commencing salary in the range of* **£1,200** *to* **£1,500** *per annum.*

The appointments will be tenable in the London area and housing assistance will be given to applicants resident outside London.

- **Applications should be addressed to BOX M 186, Offices of ENGINEERING.**

in the LONG RUN

Visit our STAND No. 309 GRAND HALL GALLERY at the MACHINE TOOL EXHIBITION 22nd June—6th July

the short cut is

F B T FIRTH BROWN TOOLS LTD SPEEDICUT WORKS, CARLISLE STREET EAST, SHEFFIELD

"SPEEDICUT"

The Hallmark of Engineers' Cutting Tools

BRITISH CELLOPHANE LIMITED, BRIDGWATER, SOMERSET, seeks

SENIOR AND JUNIOR DRAUGHTSMEN, for both **PERMANENT** and **TEMPORARY** appointments, for work on machine design and chemical plant layout. Applicants should possess at least O.N.C. and have had three years' shop experience. Five-day week, Pensions Fund Scheme for permanent appointments. Ref. No. E56.Eg.

THE TEMPORARY appointments are for a period of approximately two years' duration, subject to three months' notice and include generous subsistence allowances, and periodic home return rail fares.

ASSISTANT ENGINEER, AGE 23/30 (PERMANENT.) Applicants should have an honours degree in mechanical engineering and have had some practical works experience. The duties will be on development, improvement and maintenance of chemical and other plant. Ref. No. E57.Eg.

SECTION LEADER DRAUGHTSMAN (PERMANENT) in connection with the design of factory services. Applicants should possess H.N.C., have had at least three years' shop experience, and be familiar with all types of pipework installations. Ref. No. E58.Eg.

ASSISTANT ENGINEER, AGE 25/30 (PERMANENT.) Applicants should have a university degree and have works experience, or be an A.M.I.Mech.E. The duties will be on development, improvement and maintenance of plastic films extrusion plant and ancillary equipment. Ref. No. R48.Eg.

Write to the Personnel Officer, stating full particulars and salary required, and quote Ref. Nos as indicated. L 970

CHIEF STEAM AND POWER ENGINEER required for large new pulp and paper mill in New Zealand. Applicants must have engineering degree or equivalent qualification plus sound practical experience of boiler and power plant design and operation. Successful candidate will be required to control efficient operation and maintenance of 2—150,000 lb./hr. coal fired boilers, 1—90,000 lb./hr. Black Liquor Boiler, also 1—15 MW Pass-out Turbine. He will also be responsible for all future developments of Steam and Power Plant which includes the utilization of geothermal steam. A house to rent will be provided and all expenses to New Zealand paid including those of his family. Applicants must apply in writing giving full details of experience, qualifications, to CHIEF ENGINEER, ALBERT E. REED & CO., LTD., GROUP ENGINEERING DIVISION, LARKFIELD, NR. MAIDSTONE, KENT. L 966

ENGINEER required for Electrical and Mechanical Design and Development Work on Light Electric and Electronic Apparatus. Good degree or equivalent. Must be capable of original thought and be able to lead a small team of specialists. Previous experience not essential if training has been sound and outlook is progressive. Salary up to £1350 per annum, London area. Write full details including age, experience, employment history including present employment and salary quoting Ref.: E.D.1 on letter of application to BOX M 74, Offices of ENGINEERING.

CIVIL ENGINEERING MANAGER. Leading British Company with international organisation requires services of Qualified Civil Engineer to take control of major projects. The company has headquarters in London and will only consider applications from fully qualified civil engineers holding University degrees in civil engineering or Associate Membership of the Institution of Civil Engineers. The successful applicant will be required to take complete control of large civil engineering projects each representing several million pounds in value. Extensive experience in the organisation, design, and costing of large civil engineering works is essential. The appointment will be based on London headquarters and carry a salary within a scale of £3,000 to £4000, dependent on qualifications and experience. Pension scheme and assistance for house purchase are available. Applications stating age, experience, qualifications and present salary, which will be treated in strictest confidence, should be sent to BOX M 80, Offices of ENGINEERING.

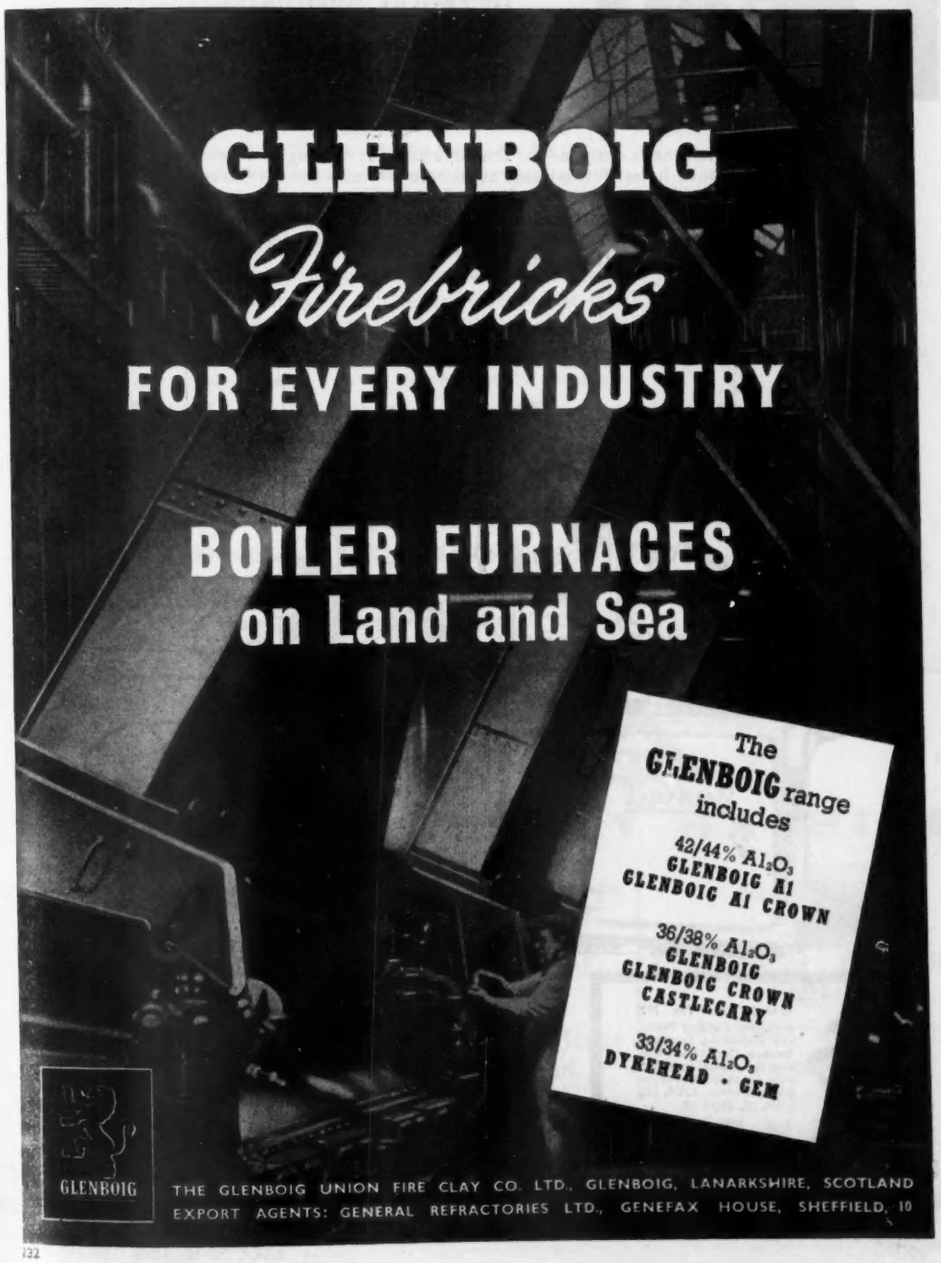
SCHLUMBERGER.

Invite applications for

GEOPHYSICAL AND PRODUCTION WORK IN OILFIELDS in many parts of the world. Candidates should hold a University degree (preferably with Honours) in Electrical and/or Mechanical Engineering. Knowledge of Electronics is an asset. Candidates should be free of military obligations. Training is done abroad on bachelor status but thereafter living conditions are also favourable to married men. The age limit is 30 years.

Applications and enquiries should be addressed to:—

SCHLUMBERGER OVERSEAS,
42, RUE ST.-DOMINIQUE,
PARIS 7e—FRANCE.
To the attention of J. L. Mathieu. M 57



Foundry Plant manufacturerers in the Birmingham area require

SENIOR DRAUGHTSMAN with mechanical handling and/or structural experience for highly mechanised cupola melting plants. Full details in confidence to:—PERSONNEL MANAGER, INCANDESCENT HEAT CO., LTD., CORNWALL ROAD, SMETHWICK. M 24

BRITISH INSULATED CALLENDER'S CABLES LTD., require

A GRADUATE MECHANICAL ENGINEER with practical experience of Rubber and/or Plastic moulding and jig and tool designing and manufacture. The appointed candidate would initially be employed with a Work(Study Unit concentrating on production techniques in an expanding Rubber and Plastic Moulding Department with an early opportunity for a man with the ability and personality to transfer to an executive position. Applications quoting Reference A/40/56, should be addressed to the STAFF OFFICER, B.I.C.C. LTD., PRESCOT, LANCS. M 11

EXPERIENCED PLANNING ENGINEERS required for production methods on medium I.C. engine components and fuel injection equipment. Pleasant working conditions, generous salary. Attractive Pension Scheme and Comprehensive Welfare Facilities.

Apply CHIEF PERSONNEL OFFICER, PETTERS LIMITED, CAUSEWAY WORKS, STAINES, MIDDX. G 662A

RESEARCH ASSISTANT. Male Assistant 25-35 years, is required for research into problems associated with fuel injection for diesel engines. Research experience plus knowledge of Fuel Injection is desirable, but some training will be given. Good general education and H.N.C. (Mech.) an advantage. Applicants should be capable of section leading after reasonable period.—Apply in writing giving full details: PERSONNEL OFFICER, SIMMS MOTOR UNITS, LTD., OAK LANE, E. FINCHLEY, N.2. L 917

Well-known Midland aero engine company requires **MECHANICAL ENGINEERING DESIGNERS AND DRAUGHTSMEN** to join teams on various aspects of engine construction. Initial salary, £650-£1000 per annum. Owing to expansion in new drawing offices with excellent working conditions departments will offer good prospects to men with initiative. Sickness benefits for families and pension fund. Full details quoting Reference AD/2, to BOX G 632, Offices of ENGINEERING.

STRUCTURAL ENGINEER with wide experience of the design and detailing of all types of steel structures and with administrative experience required to act as deputy to the Chief Engineer by large firm of London Consultants. The firm is expanding and the vacancy offers excellent opportunities for the right type of man.—Write in confidence giving details of previous experience and salary required to BOX No. 355, GLOVERS ADVERTISING LTD., 351, OXFORD STREET, LONDON, W.1. G-635

STRUCTURAL ENGINEER required by London firm of Consultants to take charge of their steel design office. Candidates must have a comprehensive knowledge of all types of structural steelwork both designing and detailing and should preferably have had some works experience. Applicants should be Corporate Members of one of the senior professional Institutions or hold similar Degrees. The post is a permanent one and there is a Staff Pension Scheme.—Please reply in confidence to BOX NO. 389, GLOVERS ADVERTISING, LTD., 351, OXFORD STREET, W.1. G 648

ESTIMATOR-RATEFIXER: required with workshop experience for the Engineering Department of factory in the Eastern Counties. Apprenticeship and National Certificate standard essential. Please write, giving age, qualifications and particulars of previous experience, to the PERSONNEL MANAGER, BEXFORD, LTD., BRANTHAM, NR. MANNINGTREE, ESSEX, or 'phone the Asst. Engineer at Manningtree 266. M 43

DRAUGHTSMEN, SENIOR AND JUNIOR, preferably with Railway or Automotive experience, required for Diesel Traction Drawing Office situated in London area, N.W.10. Apply in writing giving age, details of experience and salary required, to GENERAL MANAGER, BRITISH UNITED TRACTION LTD., 14, HANOVER SQUARE, LONDON, W.1. M 87

DRAUGHTSMEN. Applications are invited from Senior and Junior Draughtsmen with general experience in Light Electrical or Mechanical Engineering or specialised experience in Small Internal Combustion Engines or Automobile Equipment and accessories. The vacancies are in North London and salary will be commensurate with ability and experience. Please write full details including age, education, experience, employment history, including present employment and salary in strict confidence, quoting Ref. E.D.3 on letter of application to BOX M 75, Offices of ENGINEERING.

Classified Advertisements continued on Page 118

METALS ICI DIVISION

METALLURGISTS

Applications are invited from qualified **METALLURGISTS** to undertake important Control work and investigations into production processes, material specifications and product development in the brass and copper strip, sheet, rod and wire mills in the Birmingham area.

Applicants should preferably be in the age range 24-45 and hold a degree or similar qualification in metallurgy, although candidates with practical experience in this work but with other qualifications will also be considered.

There are excellent prospects of promotion to supervisory and managerial positions for suitable candidates.

On joining the Staff married men will receive a contribution towards removal (including travel) expenses, and, in approved cases, financial assistance will be given towards house purchase. The Company operates both a contributory Pension Fund and a Profit Sharing Scheme.

Application forms may be obtained from THE STAFF MANAGER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, METALS DIVISION, KYNOCH WORKS, WITTON, BIRMINGHAM, 6, quoting MPB/1/ENG. M 154

GOVAN SHAFTING AND ENGINEERING CO.

PROPRIETORS: THE STEEL COMPANY OF SCOTLAND LTD.

BRIGHT DRAWN STEEL TURNED STEEL BARS UP TO 12 in. DIA.

BRIGHT STEEL BLANKS

ANY THICKNESS IN MILD STEEL - FREECUTTING
CASE HARDENING - HIGH TENSILE, ETC.

87, HELEN ST., GOVAN, GLASGOW S.W.1

Telegrams: "PEDESTAL GLASGOW." Telephone: Govan 1145 (3 lines)

SENIOR AND JUNIOR DESIGNERS for reinforced concrete and/or steelwork required for London Office. Considerable scope for advancement. Junior assisted in study courses involving day attendance. Consideration given to holiday arrangements.—BOX M 42, Offices of ENGINEERING.

DRAUGHTSMAN required for Engine Design Schemes on small high-speed diesels must have initiative and experience. Good salary. Pleasant working conditions. Pension Scheme.—Apply CHIEF PERSONNEL OFFICER, PETTERS LIMITED, CAUSEWAY WORKS, STAINES. G650

Large Civil Engineering Company with Headquarters in the Liverpool area, carrying out railway electrification schemes require to expand their technical and drawing office staffs immediately. Applications are accordingly invited from
DRAUGHTSMEN (Mechanical or Structural)
TECHNICAL ASSISTANTS (Civil or Mechanical), qualified to a minimum of O.N.C. standard for the design, estimating and engineering sections. Excellent rates of remuneration and conditions of service, including a five day week.—BOX M 96, Offices of ENGINEERING.

CHIEF ENGINEER required by textile manufacturing company—a vertical organisation with Spinning, Weaving, Finishing and Power Plant on one site. Will be responsible for control of steam generation and utilization plant, mechanical, electrical work and for preventive maintenance. Applicants must be corporate members of one of the senior Engineering Institutes. Good superannuation scheme. House available.—Applications to PERSONNEL DIRECTOR, FERGUSON BROTHERS, LIMITED, HOLME HEAD WORKS, CARLISLE. M 133

G. & J. WEIR, LTD., CATHCART, GLASGOW, require
QUALIFIED ENGINEERS and Metallurgists for their Nuclear Energy Development Group. Applicants should have an honours degree or equivalent in Mechanical Engineering or Metallurgy. —Applications, giving full particulars of qualifications, age and experience, will be treated in confidence. They should be marked "PERSONAL" and addressed to the WORKS DIRECTOR at the above address. M 200

GRADUATE ENGINEERS, AGE 25/30, required to train for executive positions in production and works management in medium/heavy engineering industry producing earth-moving equipment in progressive and up-to-date factory.—Applications in writing in first instance giving all relevant particulars and approximate salary required to PERSONNEL MANAGER, RUSTON-BUCYRUS, LTD., LINCOLN. M 201

ASSISTANT ENGINEER (GENERATION) required for Power Company in MALAYA. Applicants should have experience in the operation of steam generating plants and have served a full apprenticeship in Mechanical Engineering. Qualifications: H.N.C. Grad.I.Mech.E. or equivalent. Age 25-30. Starting salary (including cost of living allowance) £1190-£1500 depending on experience and whether married. Free quarters or an allowance provided. Free return passages and medical attention. There is also a pension scheme.—Write BOX EG.392, c/o 191, GRESHAM HOUSE, E.C.2. M 197

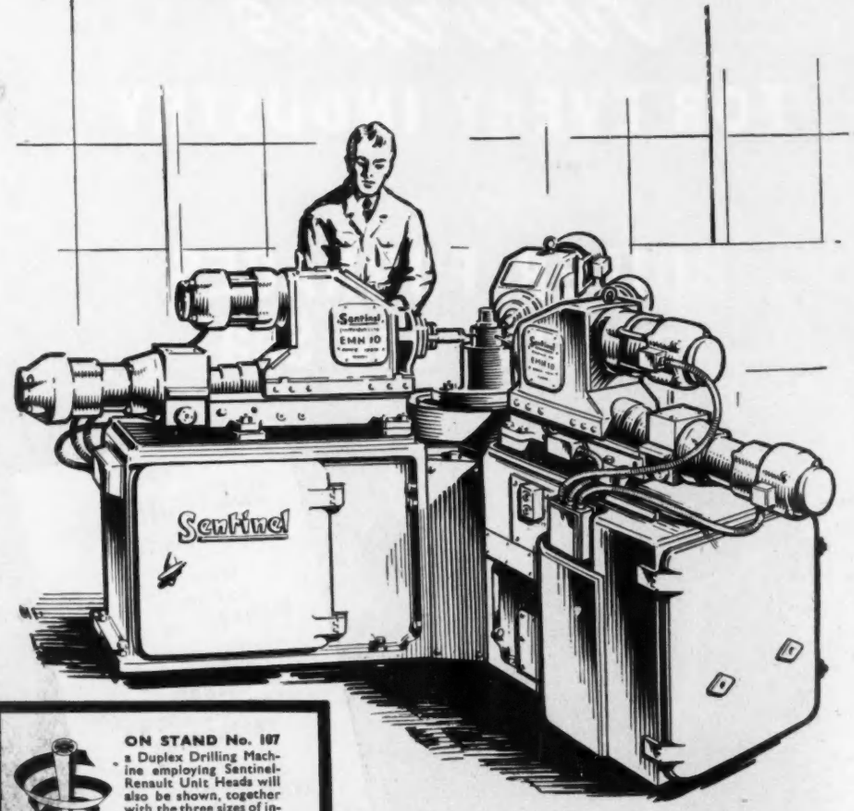
A LEADING OIL COMPANY has vacancies for
ASSISTANT DRILLERS, aged under 27, suitable for promotion to drilling supervisors. Applicants must be either mechanical engineering graduates or hold Higher National Certificate in mechanical engineering. Experience of engineering workshops, pumping equipment, ships engine-room or hydraulic machinery an advantage. Training in drilling in the U.K. will be given prior to overseas postings. Non-contributory Pension Scheme.—Write giving full details of qualifications and experience, quoting H.3779 to BOX 9043, c/o 191, GRESHAM HOUSE, E.C.2. M 198

DRAUGHTSMEN, SENIOR, urgently required by firm of Consulting Engineers. Heavy structural steelwork and platework. High salary and bonus. Comfortableworking conditions and subsidised meals. Five-day week. London area.—Write stating age, experience, and salary required to BOX L 963, Offices of ENGINEERING.

Sentinel

THREE-WAY HORIZONTAL DRILLING MACHINE

This machine is designed for the simultaneous drilling of three radially positioned holes. A fabricated steel base carries a central fixture, which holds the component for machining. The three Sentinel-Renault unit heads are mounted on standard cast iron bed extensions. The machining cycle is automatic, and is push button controlled from the front of the machine.



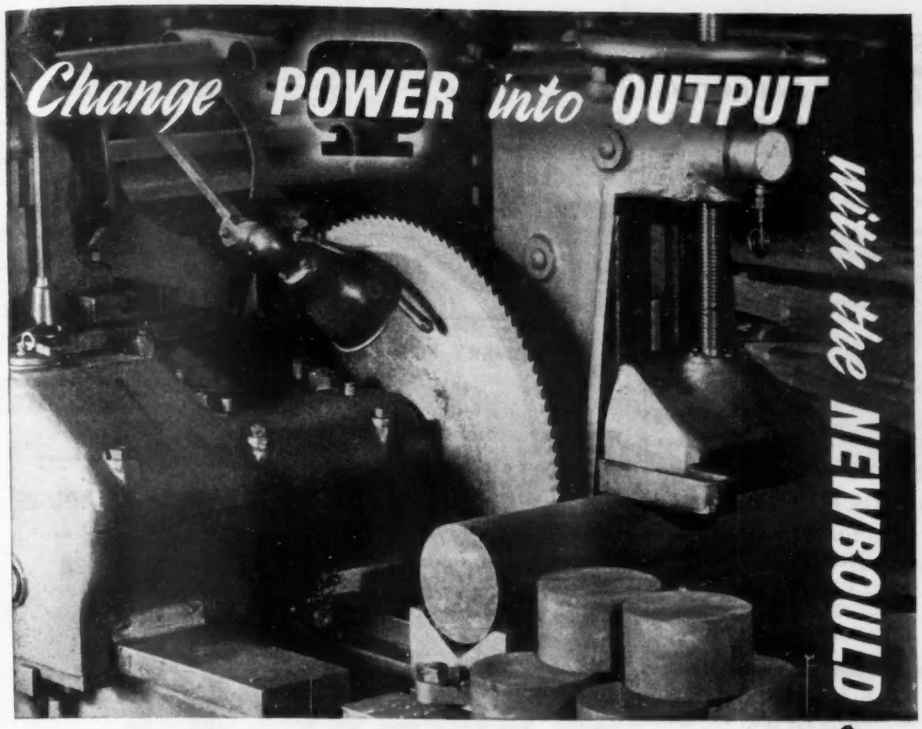
ON STAND No. 107
a Duplex Drilling Machine employing Sentinel-Renault Unit Heads will also be shown, together with the three sizes of individual Units, EMH. 10, EMH. 20, EMH. 30.

SENTINEL (SHREWSBURY) LIMITED, SHREWSBURY

TELEPHONE: SHREWSBURY 2011 TELEGRAMS: SENTNOLL SHREWSBURY

A METAL INDUSTRIES GROUP COMPANY

SS/31/3548



The scientific tooth design of the NEWBOULD segmental saw enables ferrous and non-ferrous metals to be cut at maximum feeds and speeds. Alternate roughing and finishing teeth produce free-curling, easily cleared chips, reducing friction, minimising power wastage. Wear-resistant tooth segments of SABEN EXTRA high speed steel ensure maximum life between regrinds. Differential hardening of segments gives full cutting efficiency at the teeth with toughness in the body. High tensile steel saw plate or centre ensures the overall strength and rigidity of the assembly, enables replace segments to be fitted as desired.

Size range 11 in. to 60 in. diameter.

May we send further details ?

A SABEN PRODUCT

SANDERSON BROS. & NEWBOULD LTD., ATTERCLIFFE STEELWORKS, SHEFFIELD. Est. 1776

ENGINEERS' TOOLS, HACKSAW BLADES, SAWS, MACHINE KNIVES, TOOL STEELS.

TRANSFORMER SPECIALIST ENGINEER required for a Senior Sales Post in a progressive Company. The man appointed should possess at least an H.N.C. (Electrical) and preferably be a corporate member of the I.E.E. He should have recent experience on the design of transformers up to 45 mVA, 132 kV and possess the qualities of personality necessary in a first class sales engineer. For the right man there are excellent prospects of promotion to top Management positions in an expanding organisation. Terms of employment include staff bonus and generous non-contributory superannuation. Please apply to the CHIEF PERSONNEL OFFICER, BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH, LEICS. M 15

WORKS MANAGER for Factory in Birmingham employing 500 people. Desirable qualifications: 30—45, first class engineering apprenticeship, H.N.C. or B.Sc. in mechanical engineering, good disciplinarian, managerial experience in a modern light engineering factory, good working knowledge of modern systems, cost control, production planning, quality control, work study, personnel administration, etc. The position is a permanent one, offering good opportunities with a salary commensurate with qualifications and the responsibilities to be undertaken.—Reply stating full details of schooling, technical education, business experience in chronological order, age and salary required to Managing Director, BOX M 194, Offices of ENGINEERING.

GRADUATE ENGINEERS (MECHANICAL) required immediately for a progressive Chemical Industry located in the North of England. These vacancies are for design work in the Chief Engineer's Department and are of special interest to young engineers with a flair for design and development work who have served a Graduate Apprenticeship. The age range is 26/33 and the salary within the range £1000/£1500 depending upon age, qualifications and experience. There is a scheme for assisting married men with house purchase and removal expenses. Annual bonus and Pension Schemes are attractive.—Applications, which will be treated with the strictest confidence, to BOX M 195, Offices of ENGINEERING.

SITUATIONS WANTED.

METALLURGICAL ENGINEER, B.Sc., A.I.M., 34. Agreeable personality, first-class education, wide industrial experience in the application of metallurgy to engineering; operational research, layout and design. Seeks responsible executive position with scope for initiative and organisation.—BOX M 119, Offices of ENGINEERING.

EXPERIENCED COAL AND FUEL-OIL SALESMAN with large Industrial connection in the Midlands and Eastern Counties, seeks new position where his valuable personal contacts, and knowledge of steam raising plants can be used.—BOX M 103, Offices of ENGINEERING.

THE PROPRIETORS OF BRITISH PATENT NO. 669396, for "HOT WORKING TOOLS AND ALLOYS THEREFOR," desire to enter into negotiations with a firm or firms for the sale of the patent or for the grant of licences thereunder.—Further particulars may be obtained from MARKS AND CLERK, 57 and 58, LINCOLN'S INN FIELDS, LONDON, W.C.2. M 191

THE PROPRIETORS OF PATENT NO. 653953, for "IMPROVEMENTS IN OR RELATING TO SCAFFOLDING," desire to secure commercial exploitation by Licence or otherwise in the United Kingdom.—Replies to Haseltine Lake & Co., 28, Southampton Buildings, Chancery Lane, London, W.C.2. M 140

Classified Advertisments continued on Page **120**

SOAG

FOR HEAVY DUTY MACHINE TOOLS

INGOT PLANER
Mfr. CRAVEN
8 ft. x 4 ft. x 4 ft.
4 Tool Heads
Lancashire Planer Drive

TRAVERSING HEAD SHAPER
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COMPANY MEETING.

BARTON & SONS

Demand Maintained in all Departments.

The ordinary general meeting of Barton & Sons Ltd. was held on June 14 in London, Mr. A. B. Redfern (the chairman) presiding.

The following is an extract from his circulated statement:

I am pleased to tell you that the demand for our products has kept up in all departments, production has increased, with the result that trading profits are higher at £887,563 compared with £757,605 for the previous year, and after providing for all normal charges, including £114,365 for depreciation, there remains a profit of £731,717, from which taxation of £372,764 is deducted, leaving a net profit of £358,953 compared with £290,487 for 1954. After allocating £113,254 for dividends, £5,000 for Capital Redemption and writing £77,071 off Investments in Subsidiaries, £130,000 has been transferred to General Reserve and £33,628 added to the carry forward.

Your Directors are recommending that a final dividend of 15 per cent. be paid, which together with the interim dividend of 5 per cent., makes 20 per cent. for the year; this compares with 17½ per cent. for the previous year, which was paid on the Ordinary Capital before the increase by the free scrip issue of one for six.

Towards the end of 1955 we acquired the balance of the shares in the Canadian company, Barton Tubes, Ltd. This Company has made such good progress that extensions which will double our productive capacity have become necessary and will be completed during 1956. In the early part of 1956 we exchanged the minority holdings in the South African companies and although we now have no shares in Wright, Anderson (S.A.) Ltd., we have 100 per cent. holding in Bartons Tube & Conduits Ltd.

During the year we built an entirely new factory at Walsall for The Premier Aluminium Casting Co. Ltd., and removed the whole of the plant from Birmingham. The new factory will give us a considerable increase in productive capacity and land is available for extensions.

With regard to prospects for the year 1956, there has been some slackening of demand in several industries but fortunately we have not yet experienced any serious repercussions.

The report and accounts were adopted. M 143

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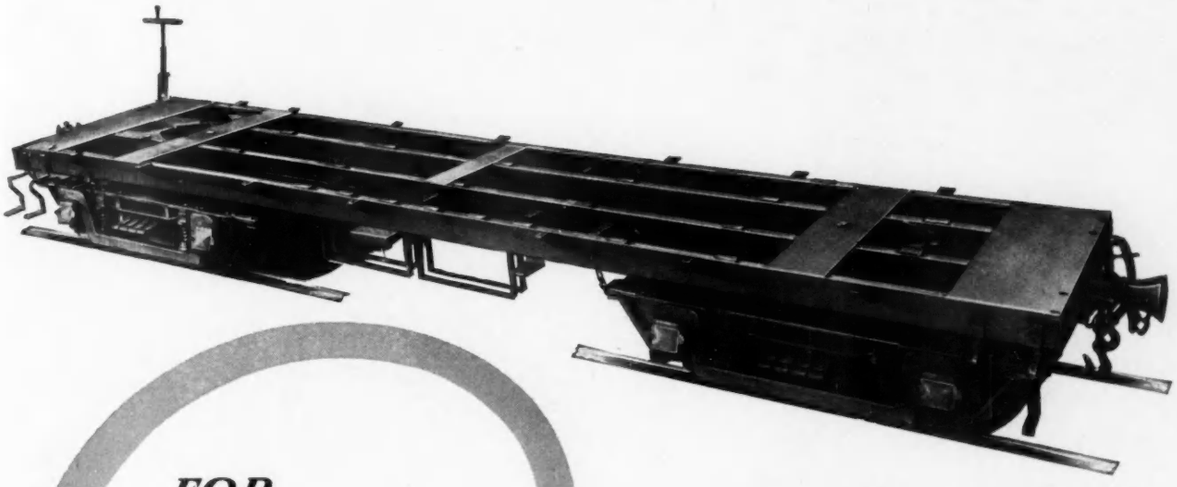

Overhead view of complete underframe

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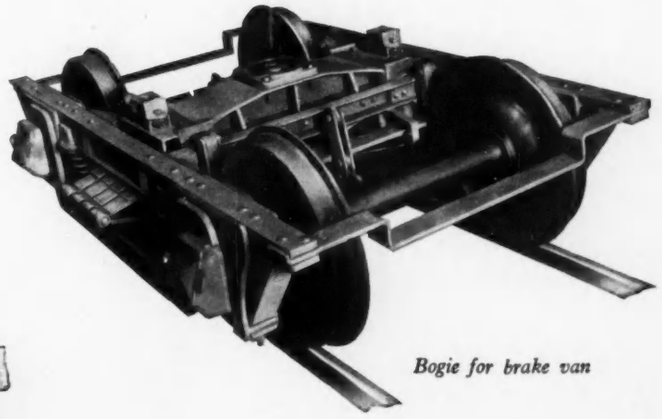
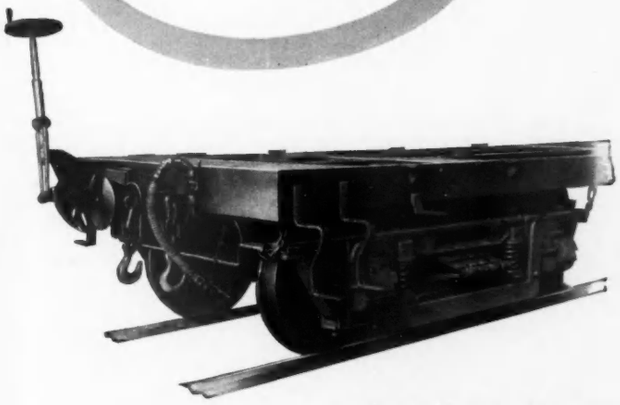


Bogie for brake van



Close-up view of handbrake end

The underframes have been built for operation on 3ft. 6in. rail gauge. The length of the complete underframes over headstocks is 30ft., while the length over couplers is 32ft. 8½in. Wheel diameters are 2ft. 6¼in., on tread. Westinghouse air brake and handbrake are fitted.

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W45 A

A TURN TO THE RIGHT . . .

At the next corner, or the next-but-one, our lady driver will turn to the right (or will it be the left?) taking steel with her in a multitude of forms. Body work, chassis, engine, the wheel she holds, the foot pedals she sometimes uses and many other components are made from steel—more often than not, Steel by LEE. Our daily output of cold rolled strip, bright drawn bars and "Trubrite" stainless steel feed the production lines of leading automobile, motor cycle, and bicycle manufacturers. Limited only by the fields in which steel is used, LEE'S products feature extensively in well-known domestic appliances, cutlery, and kitchen equipment manufacture, shipbuilding yards and aircraft plants, etc., to name but a few. A word out steel with LEE of SHEFFIELD will be a to the right.

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The Atlas Copco LSS 81 High-Capacity Disc Grinder has the speed, has the power. The new vane-type air motor has ample power to maintain the peripheral speed of 15,000 ft./min. necessary to obtain the maximum output from these wheels. Yet for all its power it weighs as little as 11 lbs., is quiet, simple to operate, cheap to run and safe.

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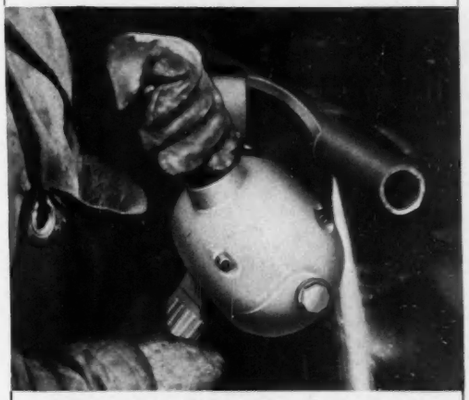
The Atlas Copco LSS 81 High-Capacity Disc Grinder does!

An Atlas Copco LSS 81 Disc Grinder fitted with one of the new nylon-reinforced hub wheels smooths flame-cut edges on a heavy steel plate.

Taking off excess welding material prior to sanding. New hub wheels are capable of tackling more than 15 different notching, cutting and dressing jobs in succession.



An Atlas Copco LSS 81 Disc Grinder cutting through piping. This grinder realises the high-productive potentialities created by recent developments in abrasives.

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An Illustrated Weekly Journal

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